Annual Report

WESTERN SHEEP BREEDING LABORATORY

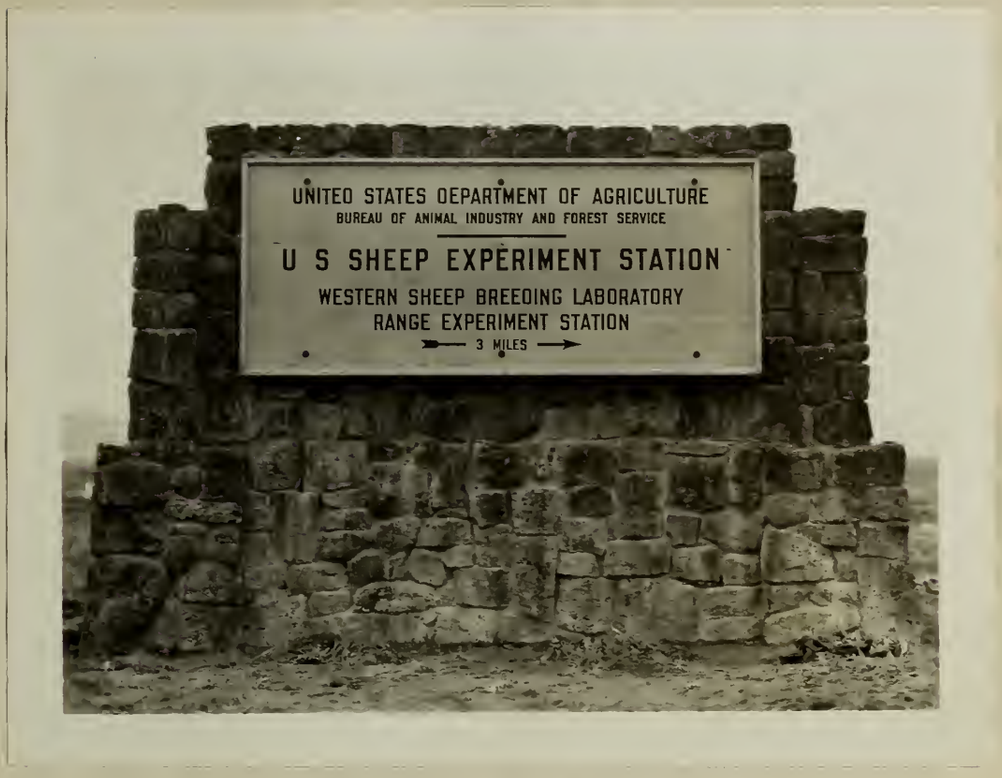
— AND —

UNITED STATES SHEEP EXPERIMENT STATION

DUBOIS, IDAHO

JUNE 30, 1941

This report of research projects not yet completed is intended for the use of administrative leaders and workers in this or related fields of research, and not for general distribution.



A 1940 addition. This signboard, 12'0" by 5'0", is mounted on a lava rock structure 18'6" long 12'0" high and 4'0" wide at the base, and is located on U. S. Highway 91 at the intersection of the Sheep Station road. A similar signboard is on the opposite side. The structure is placed at right angle to the highway and can easily be read from passing vehicles.

DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS
OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING
WITH THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	P. F. Burgess, University of Arizona, Tucson.
CALIFORNIA:	C. B. Hutchison, University of California, Berkeley.
COLORAD:	H. J. Henney, Colorado State Agricultural College, Fort Collins.
IDAHO:	E. J. Iddings, University of Idaho, Moscow.
MONTANA:	Clyde McKee, Montana State College, Bozeman.
NEVADA:	S. B. Doten, University of Nevada, Reno.
NEW MEXICO:	Fabian Garcia, New Mexico State College of Agriculture, State College.
OREGON:	W. A. Schoenfeld, Oregon State College, Corvallis.
TEXAS:	A. B. Conner, Agricultural and Mechanical College of Texas, College Station.
UTAH:	A. H. Walker, Utah State Agricultural College, Logan.
WASHINGTON:	E. C. Johnson, Washington State College, Pullman.
WYOMING:	J. A. Hill, University of Wyoming, Laramie.

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA: Ernest B. Stanley, Head, Department of Animal Husbandry, College of Agriculture, University of Arizona, Tucson.

CALIFORNIA: *James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.

COLORADO: *Herbert B. Osland, Head, Department of Animal Industry, Colorado State College of Agriculture and Mechanics Arts, Fort Collins.

IDAHO: *C. W. Hickman, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.

MONTANA: Richard T. Clark, Head, Department of Animal Husbandry, Montana State College, Bozeman.

NEVADA: Charles E. Fleming, Department of Range Management, College of Agriculture, University of Nevada, Reno.

NEW MEXICO: Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanics Arts, State College.

OREGON: Ray G. Johnson, Department of Animal Husbandry, Oregon State Agricultural College, Corvallis.

TEXAS: Bruce L. Warwick, Department of Animal Industry, Texas Agricultural and Mechanical College, College Station.

UTAH: Ralph W. Phillips, Head, Department of Animal Husbandry, Utah State Agricultural College, Logan.

WASHINGTON: **Howard Hackedorn, Head, Department of Animal Husbandry, State College of Washington, Pullman.

WYOMING: Fred S. Hultz, Head, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

(*) Messrs. Robert F. Miller and Ivan Watson, and Dr. Daniel E. Brady substituted for Messrs. Wilson, Osland and Hickman, respectively, at the 1940 Collaborators' meeting.

(**) Deceased.

ROSTER OF PERSONNEL

U. S. SHEEP EXPERIMENT STATION and WESTERN SHEEP BREEDING LABORATORY,
Dubois, Idaho, as of June 30, 1941

Name	Rating	Date entered on duty	General Duties
Nordby, Julius E.,	Principal Animal Husbandman, P-6	Mar. 1, 1938	Director
Smith, Stanley L.,	Animal Husbandman, P-4	Oct. 1, 1935	Construction & Maintenance
Terrill, Dr. Clair E.,	Animal Husbandman, P-4	July 3, 1936	Geneticist, physiologist
Stoehr, John A.,	Assoc. Animal Husbandman, P-3	Aug. 28, 1928	Flockmaster
Pohle, Elroy M.,	Assoc. Animal Fiber Technologist, P-3	May 2, 1938	Wool technologist
Schaefer, Chester F.,	Assistant Clerk, CAF-3	June 22, 1936	Chief clerk
Harrison, Raymond H.,	Assistant Clerk, CAF-3	Oct. 25, 1937	Assistant clerk
James A. Barker	Assistant Agricultural Aid, SP-4	Aug. 16, 1939	Laboratory assistant
Jeffery, Lee C.,	Foreman of Farm Laborers, CU-4	June 7, 1924	General maintenance pumps, equipment
Hohman, Max E.,	Farm Laborer, CU-3	Apr. 1, 1935	Shepherd
Rasmussen, Henry, Jr.	Jr. Farm Laborer, CU-2	July 1, 1926	Farm laborer
Phillips, Walter H.,	Truck Driver	Mar. 16, 1935	Truck driver
Powell, Fred A.,	Jr. Farm Laborer, CU-2	May 1, 1935	Teamster
Landacre, Harold E.,	Jr. Farm Laborer, CU-2	Apr. 6, 1939	Truck driver, general maintenance
Goldman, James R.,	Jr. Farm Laborer, CU-2	May 1, 1939	Shepherd
Maloney, Thomas J.,	Jr. Farm Laborer, CU-2	Sep. 22, 1939	Farm laborer
Maloney, George	Jr. Farm Laborer, CU-2	Apr. 8, 1941	Farm laborer
Landacre, David N.,	Classified laborer	Apr. 8, 1940	Farm Laborer
Mayne, Jesse L.,	Classified laborer	Mar. 18, 1941	Shepherd
Beck, Claud T.,	Herdsman	Apr. 5, 1940	Camp tender
Black, Adam H.,	Herdsman	Mar. 20, 1941	Shepherd
Gibbs, John H.,	Classified laborer	Apr. 1, 1941	Teamster
Hoopes, Wendell L.,	Classified laborer	Apr. 16, 1941	Farm laborer
Nantz, Mrs. Dorinda R.,	Unskilled laborer	Jun. 16, 1941	Janitress & cook

Student Employment

The following students have been employed as indicated from collaborating states:

Name	College	Time employed
George C. Hughes	Montana State College	6-13 to 9-12-38
Glenn J. Spaulding	Washington State College	6-12-39 to 9-14-40
Gerald L. Crow	Colorado State College	6- 5 to 9- 4-39 5-28 to 8-27-40
Thomas D. Watkins, Jr.	University of California	5-28-40 to 8-27-41
George M. Sidwell	Utah State College	9-25-40 to 6-30-41
William L. York	University of Idaho	5-19 to 8-18-41
Raleigh E. Patterson	Texas A & M College	6-16 to 9-15-41
C. LeRoy Rainville	University of Arizona	6- 2 to 9- 1-41
Sylvester E. West	University of Wyoming	6-13 to 9-12-41

Physical Plant

Land:

The U. S. Sheep Experiment Station and Western Sheep Breeding Laboratory now have available for grazing use the following parcels of land:

	Acres
At headquarters near Dubois, Idaho (spring-fall range)	27,280
Summer range, 40 miles from headquarters in Montana	16,650
Modoc ranch (Baugh, Hansen, Boatman)	2,272
Total	46,202

The Station also has a summer grazing permit for approximately 1000 sheep (drys) on the Targhee National Forest, and a winter range permit for approximately 2000 sheep on the Salmon National Forest. Winter grazing terminates about the middle of January.

Buildings:

The following buildings are now available for use as facilities for carrying on the work at the Station:

Laboratory - 6 offices, 1 reading room, 5 laboratories, dimensions 36'0" x 64'0".

Laboratory barn - central portion 40'0" x 26'0" and one wing at either side 40'0" x 26'0".

Two pumphouses - (1) housing small pump and repair shop for farm equipment, etc., dimensions 36'0" x 18'0"; (2) combination pumphouse (for large pump) and three car garage, dimensions 45'0" x 24'0".

Sheep sheds - consisting of sheep barn, lambing shed, cow stable, granary, paddocks, dipping vat, corrals and shearing shed, dimensions 230'0" x 526'0" and 100'0" x 18'0".

Horse barn - combination horse barn (38'0" x 74'0") and machine shed (88'0" x 36'0").

Two reservoirs for water storage - one 20,000 gallon capacity and the other 100,000 gallon capacity.

Three garages (in addition to pumphouse-garage) - consisting of one two-car, one four-car and one ten-car garage.

One combination dwelling and mess hall - consists of one five-room apartment and mess hall, dimensions 100'0" x 30'0".

Seven dwellings - one two story frame, six one story frame.

Two pumps - one delivering 850 gallons of water per hour and one delivering 3600 gallons of water per hour, both pumps pumping water from a distance of about 690 feet below the surface.

One laborer's cottage - that accommodates five laborers.

Fences - approximately 60 miles of fences.

Improvements and Additions in 1941

Approximately 500 feet of sidewalk was completed.

Additional fire hose and a hose reel were purchased and a shed for housing one unit of fire fighting equipment was constructed. A large fire siren with a range of two and one-half miles was also purchased and installed.

One flume type trough was purchased for permanent installation on the Modoc area, one for the northeast corner of Station headquarters and two for the Odell Creek range on Sheep Mountain.

Landscaping was virtually completed on buildings 18 B D and 20 B D. In addition five new lawns were seeded and plans completed for the landscaping of building 24 B D.

A new sign was erected at the intersection of the Station entrance road with U. S. Highway No. 91.

Materials for street lights were purchased and installed.

Materials were purchased for the construction of a new dipping vat at the northeast corner of Station headquarters.

Approximately 85% of the materials were purchased for the construction of two new cottages and a new 4-inch water line to serve these and other tentatively planned dwellings was installed. Construction of these two new buildings was started on June 16.

Anticipated Improvements and Additions 1941-42

Two cottages, 28'0"x30'0" each. Construction was started on these on June 16.

Approximately 300'0" of sidewalks.

Dipping vat on spring range area to replace present vat which is in bad state of repair. This will facilitate the dipping of sheep without having to trail to headquarters where present vat is located.

Road improvement at headquarters and on the range.

Putting down additional lawn space and landscaping.

Improving old fences and building 15 miles of new fences.

Installation of galvanized water troughs on high summer range to facilitate the use of springs for supplying adequate water and to eliminate the present need for trailing to water in some areas of the summer range.

It is probable that a suitable hay storage house can be profitably constructed by use of CCC labor.

It may become possible to get under way with the construction of a service center late in 1942 or in 1943. Details for this construction

are not complete. However, the building will, it is planned, supply badly needed space for group meetings that are rapidly outgrowing the library space in the laboratory building, and provide adequate accommodations for a presentable eating space for the increasing number of visitors, and the unmarried personnel at the Station, and to provide dormitory space for Laboratory and Station visitors.

Laboratory Equipment Purchases in 1941:

The following major laboratory equipment was purchased during the year: Photographic equipment (print washer, clock, develo-o-tank, twin light stands with reflectors), haemacytometer, fluorescent lamp, fan, hygrothermograph, laboratory scale, microscope slide filing cabinet, adding machine, calculator, 9 Navajo rugs and some additional office furniture.

A Garden Corner Showing Three Year Development

Objective of the Western Sheep Breeding Laboratory

The objective of this Laboratory is the improvement of range sheep that excel present sheep in adaptability, yield and quality of wool, and in lamb production.

In the pursuit of this objective, all of the sheep at this Laboratory are produced under range conditions, so the progress that is made is directly applicable to range practice. Moreover, the breeding program is so organized that any progress is substantially fundamental progress in germ plasm reorganization, hence is of a permanent nature.

Inbreeding is used in order to concentrate during the least possible timethe desirable characters such as the most acceptable market form of lambs, and the production of an increased quantity as well as quality in wool. The characteristics in sheep that are of greatest value in range production are given the most emphasis in the breeding program.

Research Line Projects
of the
Western Sheep Breeding Laboratory

The following research line projects are in effect at the Western Sheep Breeding Laboratory:

1. Development of systems of breeding for locating strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:

(a) The development of closely inbred strains by such matings as sire and daughter, and brother and sister.

(b) The development of moderately inbred strains by resorting to half-brother and half-sister matings.

(c) The development of strains by selection, based on the selection of proved sires with subsequent line breeding to these sires.

(d) The development of inbred lines with special reference to very important characters that are of economic importance to range sheep such as mutton form, length of staple in fleeces of wool, and faces that are free from excess wool covering or wool blindness.

2. Determination of the inheritance of various undesirable characteristics of Rambouillet sheep such as defective jaws, abnormalities in the growth of wool, hairiness in fleeces of wool and excessive skin folds or wrinkles.

3. Studies in the physiology of reproduction of Rambouillet sheep, as they may contribute to the program of the Western Sheep Breeding Laboratory, including

(a) Sexual maturity of Rambouillet ram lambs

(b) Quality of semen in its relation to fertility

(c) Factors affecting fertility of ewes.

4. Studies in the physiology of wool production of Rambouillet sheep with reference to fiber uniformity within and between various regions of the fleece in relation to the total uniformity of the fleece.

5. Determination of the relation between the fleece characteristics of weanling and yearling range Rambouillet sheep for the purpose of evaluating animals at the earliest possible age. This research line project is integrated with the project BAI-b-2-6, "Investigations of wool and other animal fibers", with special relation to the research line project number 3 thereunder.

6. Analysis of records of the characteristics of sheep and wool to determine the usefulness of such records in the program of the Western Sheep Breeding Laboratory. This research line project is integrated with similar analytical work of the project BAI-b-2-1, "Sheep breeding investigations" and particularly with the research line project number 11 thereunder.

Director's house in July 1938

Director's house in July 1941

This and other pictures that have a bearing on landscaping show the progress that has been made in three years.

Research Line Projects
of the
U. S. Sheep Experiment Station

The following research line projects are in effect at the U. S. Sheep Experiment Station:

BAI-b-2-1. Sheep Breeding Investigations:

1. Selective mating and linebreeding of Columbia, Corriedale and Targhee sheep for the development of strains of sheep for range production. (In the fall of 1940, 10 Columbia, 5 Corriedale and 8 Targhee lines were organized.)

2. Studies in the physiology of reproduction as that may be helpful in an analysis of fertility and the associated reproductive processes in ewes, and in the fertility of rams. This involves studies in physiology and also environment as that may influence reproduction.

3. Analysis of records of the characters of sheep and wool to determine their value in the sheep breeding program. This involves an analysis of records that have accumulated at the U. S. Sheep Experiment Station and Western Sheep Breeding Laboratory since they were established.

4. The crossbreeding of finewool range ewes to rams of the Columbia and Targhee breeds for the purpose of studying their efficiency in grading up finewool flocks to the respective types of these two breeds. This is done through the cooperation of collaborating stations.

BAI-b-2-3. Sheep Management Investigations:

1. Studies of methods of grazing management that will permit the fullest use of spring-fall range in the Intermountain region and to obtain the highest possible forage production. These studies are made in cooperation with the Forest Service.

BAI-b-2-6. Investigation of Wool:

1. Studies of the influence of breeding and environment on the growth and quality of wool. (Some work in scouring studies is done in cooperation with the Agricultural Marketing Service.

Summary of Ewes in Breeding Pens - Special Research Project
1940-41 Breeding Season

Pen No.	Ram No.	No. of ewes	Type score	Yearling body wt. (lbs.)	Adj. fl. wt. (lbs.)	Adj. fl. length (cms.)	Inbreeding coefficient	
							Dams	Offspr.
18	3340R	11	2.21	87.64	9.35	5.65	19.41	31.17
18-	438WP	31	2.63	80.06	8.57	5.09	15.10	0
19	3670R	24	2.24	86.88	10.00	5.67	14.82	18.93
20	142RW	24	2.42	86.92	9.99	6.08	4.58	12.54
21a	142RW	13	2.46	84.31	10.88	6.94	5.62	3.65
21b	2219W	15	2.40	86.87	9.88	7.01	0.41	9.86
22	2636R	29	2.62	86.17	9.92	5.62	3.42	15.32
23	3382R	24	2.29	83.75	9.04	5.75	5.07	18.09
24	3835R	26	2.36	86.54	10.37	5.82	5.90	15.10
25a	2592W	16	2.71	83.44	9.49	5.78	0	4.69
25b	2808W	14	2.50	88.93	9.62	5.64	0	5.36
26	K253	25	2.47	88.20	9.50	5.63	0	6.00
27	3167R	24	2.28	93.08	9.79	6.01	8.18	21.07
28	7174E	23	2.46	89.74	9.25	5.65	0	16.30
29	466WP	26	2.53	84.96	9.70	5 73	0	0
30	3705R	24	2.51	83.29	8.91	5.70	3.13	13.85
31	3428R	15	1.93	88.86	8.68	5.94	4.16	12.62
31-	2251W	15	2.16	88.40	9.03	5.59	3.60	9.67
32	4RW	24	2.32	86.33	10.48	5.82	4.10	13.47
33	30RW	23	2.57	85.83	10.01	5.71	2.09	5.51
34	250RW	17	2.59	83.00	8.73	5.98	9.55	15.97
35	6492	23	2.48	88.61	8.32	5.34	0	16.30
36	2260W	24	2.57	85.63	8.77	5.35	0	4.69
37	3773R	28	2.40	85.68	9.79	6.13	0.69	11.28
38	3793R	29	2.70	87.14	9.28	5.48	0.26	1.73
39	2685	24	2.56	84.08	8.74	5.57	0	6.53
40	2498W	23	2.52	90.00	9.93	5.51	0	0
41	5944	24	2.54	84.71	9.57	5.63	0	8.33
42a	2222W	12	2.75	91.83	9.33	5.15	0	3.13
42b	135WP	11	2.70	88.91	9.25	5.03	0	0
43	1227	25	2.59	86.68	9.14	5.31	0	5.00
44	3843R	23	2.67	84.09	9.14	5.17	0	0.89
45	438WP	24	2.68	89.04	10.02	5.17	0	0
46	9384	23	2.58	88.83	9.68	5.28	0.07	0.69
47	2219W	19	2.60	88.00	9.26	5.22	0.67	0.19
48	2562W	22	2.59	88.00	9.83	5.42	0	0
49	2214W	23	2.57	94.78	10.46	5.33	0	3.26
50	2560W	23	2.42	84.87	9.12	5.62	0	7.07
51	3774R	27	2.54	90.33	10.30	5.51	0.29	1.17
	TOTAL	850	2.49	86.90	9.52	5.62	2.70	8.02

General Summary of Research Program
(See details in subsequent pages)

Progress in Inbred Lines:

In 1941 lambs were born from 100 pen matings. Fifty nine of these were inbred or potential inbred lines, 36 of which were Rambouillets, 10 Columbias, 8 Targhees and 5 Corriedale lines. The lambs from two lines had an average coefficient of inbreeding of over 25 percent, in 19 lines between 12.5 and 25 percent and 19 lines were between 6.25 and 12.5 percent.

In the 59 inbred lines about 13 percent of the ewes were mated to their sires, 24 percent to their half brothers and 31 percent to less closely related rams. About 31 percent of the ewes were mated to unrelated rams.

Rambouillet lines 21, 30, 32, 34 and 38 are outstanding in clean weight of fleece. Lines 21, 34, 38, 43 and 50 have very good length of staple. There appears to be no consistent change in body weight, length of staple and clean weight of wool in 15 of the inbred lines as inbreeding progresses.

Nearly half of the lines had higher values for the more inbred lines and about half had lower values. It is difficult to state what effect divergence has had up to this time as original differences in the flock selections may account for some of the difference that is in evidence.

Pen 21 originally selected for long staple, and bred for that characteristic since the beginning in 1937, is considerably ahead of the average of all pens in length of staple and clean wool yield. In staple length the 1940 yearling ewes produced 2.67 inches (adjusted to 12 months) against 2.24 for the average and exceeded the average of all pens by .72 pounds of clean wool, but only .4 of a pound on the in grease basis. This dif-

ference between "in grease" and clean wool production clearly shows that wool should be sold on its merits.

The open face character appears to be highly heritable with rams and ewes breeding very much as they are with respect to this character. The number of open face ewes and rams is increasing. Over a period of years ewes with open face have had the advantage over ewes with wool blind faces by 6 to 8.5 lbs. of lamb weight at weaning time per year.

Progeny Tests:

One hundred and sixty-seven progeny tests have been studied to date. Seventy-seven were based on daughter-dam comparisons, by sires, on yearling offspring and ninety were based on weanling offspring by sires and from comparable groups of ewes.

Twenty-two rams were found to be outstanding in the improvement of their offspring for body weight, mutton type, fleece weight and length, open face and freeness from skin folds. Eighteen rams sired offspring inferior to the dams. Progeny testing appears to be a sound method in the selection of producing rams.

Inbreeding in Lines 18 and 19:

In the fourth generation of inbreeding in these two lines the birth weight of lambs is .7 lbs. less than the original selection, the yearling body weight 5.51 lbs. less, and the coefficient of inbreeding is 27.87 as against 1.41 percent in the original selection. In body measurements there was enough difference in the progeny from different sires to indicate that body measurements can be influenced by sire selection. It appears from this study that the Laboratory Rambouillets will endure considerable

inbreeding before their commercial value is disrupted materially.

Size as a Factor in Production:

Eight hundred and thirty-six ewes of the Corriedale, Columbia, Rambouillet and Targhee breeds were divided by breeds into three weight groups for each breed and representative for each breed. Based on yearling weights, the lifetime averages of fleece production were in favor of the ewes that were the heaviest as yearlings. The heaviest yearling ewes had also a heavier lifetime average and produced more pounds of lamb per ewe as a lifetime average.

Milking Ability of Range Ewes:

The ewes that were rated as the heaviest milkers appear to have the heaviest lambs at birth and also at weaning time. They also appeared to have a higher percentage of lambs at weaning time. Rating for milk production appears to have some value in selection.

Semen Tests:

Semen tests were made on 128 rams. One hundred and two of these were used. Three of the 102 were suspected as being sterile and proved so on trial. The number of spermatozoa ejaculated during a 30-minute period appears to be a good indicator of the ram's ability to sire offspring. Failure to make use of semen tests would probably have resulted in a 10 percent smaller lamb crop under our conditions where only one ram is placed with each group of ewes.

Lifetime Wool and Other Production Factors:

It appears in high wool producing flocks that ewes are not safely

culled if the culling is based upon only one year's fleece production. It may be the ewe's off year. Lifetime averages for ewes producing less than 9 pounds as yearlings has been over 10 pounds.

Phosphorus Studies:

It appears that there may be a practical advantage in fortifying rations for breeding ewes following a year when the grass is particularly dry and the browse relatively inedible. Moreover, alfalfa hay may prove low enough in phosphorus to produce a deficiency in blood phosphorus in pregnant ewes.

Clean Yield Determinations in Wool:

About 1200 wool samples and 45 whole fleeces have been scoured during the 1941 fiscal year.

It appears that the statement can be made that there is a larger variation in fleece yield on the clean basis than in the grease basis. This would tend to emphasize the importance of clean fleece studies, in order that the reliability in selection may be more assured.

Fiber Quality Studies:

Six thousand one hundred and ninety-four wool samples have been cross-sectioned and studied for fineness, variability and medullation during the year.

In order to expedite these studies a rapid method has been developed for determining fineness and variability. A method has also been developed for determining percentage of medullation.

A number of studies are under way as described in subsequent pages

with a view of determining the most accurate and practical methods of appraising fleece values.

Inheritance of Skin Folds:

Consistent progress is being made in removing folds and wrinkles in the skin. Seventy percent of the Targhee weanling lambs were free from neck folds. About 59 percent of the Rambouillet weanling lambs were smooth or had only a few small neck folds. Only 1 percent of the Columbia and Corriedale weanling lambs showed moderate neck folds.

Inheritance of Horns:

Progress is clearly evident in the elimination of the factor for horns in Columbias and Targhees. One percent only of the Columbia 1940 ram lambs had horns. Twenty-six percent had scurs and 73 percent were polled. Only 5 percent of the Targhee ram lambs had horns, 43 percent scurs and 53 percent were polled. (See subsequent pages for change from the 1939 ram lambs.)

Inheritance of Brown Color:

Some improvement appears in this factor. In the Corriedale, Targhee, Columbia and Rambouillet breeds, respectively, in 1940 the percentage with color was 30, 25, 14 and 10 as compared with 1939 when the percentages were 37, 25, 17 and 12.

Occurrence of Abnormal Lambs:

While only a few deformed lambs are born the abnormal lambs include for the most part lambs with black color. The proportion of abnormal lambs continues higher for the crossbred breeds than for the Rambouillets.

Length of Gestation Periods:

In a study of 2500 gestation periods it has been found that they vary from 141 to 159 days with Rambouillets averaging 151 and Columbias the lowest of all breeds with 148 days. It appears that late season breeding shortens the gestation period and that advanced age tends to lengthen the period. Single births appeared to have a slightly longer (.6 day) gestation period than twin births. Sex did not appear to have any influence on length of gestation.

Comparison of Clean Yield for Body Sorts with Entire Fleece:

For experimental purposes for body sorts studies it is necessary to scour only one-half of the fleece as the sorts were in close agreement with the other half of the fleece.

Shrinkage Studies Involving Fine and Coarse Wool:

In all cases, involving lots of fine as contrasted with coarse wool for Rambouillets, Corriedales, Columbias and Targhees the fine wool yielded a smaller percentage of clean wool than the coarser wool.

Moisture Tests in Wool:

It appears that the moisture content of wool is higher at this Station than it is in the same wool when tested for this factor in the Agricultural Marketing Service Laboratory, Washington. Further comparisons of this are being made.

Cooperative Work with the Forest Service:

At Dubois, Idaho, in cooperation with the Forest Service, grazing studies on spring-fall sagebrush ranges have indicated that use of rotation management during the spring grazing season and stocking on the basis of slightly in excess of one sheep month per surface acre on good range, one-half sheep month to be secured in the spring and one-half to be retained for fall use, will permit range recovery from serious droughts similar to that occurring in 1934. Range reseeding, using crested wheatgrass, of abandoned land segments of the sagebrush type in the Upper Snake River plains is a profitable method of range improvement.

Cottage before landscaping in July 1938

The same cottage in July 1941
showing growth and influence
of landscaping materials.

Report of Research Projects that Are Designed
to Contribute to the Main Objective of the Laboratory

Progress in Inbred Lines:

Offspring were born in 1941 from a total of 59 inbred or potential inbred lines. These were composed of 36 Rambouillet, 10 Columbia, 8 Targhee and 5 Corriedale lines. Offspring from 2 inbred lines had average coefficients of inbreeding of over 25.00 percent, 19 lines were between 12.50 and 25.00 percent, and 19 lines were between 6.25 and 12.50 percent. In 6 of the remaining 19 lines, no inbreeding has been effected to date.

In the 59 inbred lines about 13 percent of the ewes were mated to their sires, 24 percent to their half brothers, and 31 percent to less closely related rams. About 31 percent of the ewes were not related to the rams to which they were mated. Many of these were included in new lines.

Some effect of divergence is apparent in a few of the Rambouillet lines, although this may be partly due to original differences in flock selections or to the particular rams now heading these lines. Rambouillet lines 21, 30, 32, 34 and 38 are outstanding in clean weight of fleece. Lines 21, 34, 38, 43 and 50 have particularly good length of staple. Lines 26, 28 and 36 are highest in body weight. These effects may indicate that we have been particularly fortunate in the selection of foundation stock in these lines, although some of the above lines have attained an appreciable degree of inbreeding. A number of other lines show considerable promise but have not yet attained an appreciable degree of inbreeding.

Studies of important characters such as body weight, length of staple, and clean weight of fleece in 15 of the more inbred lines show no consistent change with increasing degrees of inbreeding. Nearly half of

the lines had higher values for the more inbred animals and nearly half had lower values while in a few lines there was little difference. More definite changes may become apparent with higher degrees of inbreeding.

Progeny Tests of Range Sheep:

Results from a total of 167 progeny tests have been completed during the year. Of these 77 were based on daughter-dam comparisons, by sires, on data taken of yearling offspring, and 90 were based on observations on weanling offspring by sires and from comparable groups of ewes. In evaluating results of progeny tests emphasis has been placed on body weight, mutton type, fleece weight, length of staple, face covering, and skin folds. Other characters have been observed and considered but have been given only minor emphasis.

About 22 rams were found to be particularly outstanding in the improvement of their offspring. Only one of these, however, was definitely superior in each of the five important characters. A total of 18 rams, which had very good wool and body score records of their own, sired offspring which were definitely inferior to their dams. Only two of these were inferior in each of the five important characters.

Over three-fourths of the 62 rams (more than one ram was used in some lines) used in inbred lines in the fall of 1940 had been proven by progeny test. Pens of ewes for testing rams were available for 34 Rambouillet rams and 6 Columbia rams in the fall of 1940. In the other two breeds rams are tested in the regular lines when the performance of the ram in the line and the records of available young rams warrant a change.

In general the performance of rams as measured by progeny test was

consistent with the ram's own records for the particular characters considered. This was not true in every case, however, and there were considerable differences in progeny test results among rams with very similar fleece and body records. It is believed that progeny testing of rams is essential to insure that the selection of rams is kept on a sound basis.

Inbreeding in Rambouillets:

Investigations on the effects of inbreeding in Rambouillets have been largely confined to pens 18 and 19 which have been inbred since 1929. Offspring were born this year in the second to fifth generations but largely in the third and fourth. These pens are considered as one line yet as they have common origin and have not been separated long enough for differences due to inbreeding to appear.

There appears to be a consistent decline in all quantitative characters measured, with succeeding generations and increasing degrees of inbreeding. This is illustrated in the following table for body weights and measures for all sheep in these lines which have reached yearling age:

				At yearling age after shearing			
Generation	No. hd.	Inbreeding coefficient (percent)	Birth weight (lbs.)	Body weight (lbs.)	Width of chest (cm)	Depth at heart (cm)	Ht. at withers (cm)
0	73	1.41	9.20	81.63			
1	72	4.38	9.48	93.18	19.48	29.66	65.13
2	69	17.60	9.55	88.86	19.17	29.54	63.95
3	59	22.30	9.50	85.12	18.95	28.98	62.45
4	26	27.87	8.50	76.12	18.28	28.03	58.67

This decline in size and weight with succeeding generations was also evident within the offspring of individual sires. There were definite differences, however, in body measurements of offspring from different sires within a given generation particularly for body weight, width of chest

and height at the withers. This would indicate that although some decline in size and weight with increasing degrees of inbreeding may be inevitable in this line, it is probable that these characters can be influenced to a certain extent by the selection of the sire.

Size as a Factor in Production:

Studies have been made of the selection of range ewes based on the body weight taken in the fall as yearlings. This is the time at which the most intensive culling of ewes is done. On the basis of fall yearling body weight 303 Rambouillet, 241 Corriedale, 209 Columbia and 83 Targhee ewes were divided into 3 groups for each breed; i.e., the lightest quarter, the middle one-half and the heaviest quarter. The dividing weights for the lightest quarter and the heaviest quarter was below 106 pounds and above 118 pounds for the Rambouillets, below 101 pounds and above 115 pounds for the Corriedale, below 115 pounds and above 130 pounds for the Columbia, and below 113 pounds and above 128 pounds for the Targhee.

Lifetime (2-5 year) averages of body weights were consistent with the yearling weights indicating the reliability of selecting on yearling weights. The differences between the lightest quarter and the heaviest quarter in average fall yearling weight was 22, 26, 27 and 30 pounds as compared with differences in the lifetime average of 16, 20, 19 and 18 pounds for the Rambouillets, Targhees, Corriedales and Columbias, respectively. Thus the differences due to selection were less when lifetime averages were considered.

The groups of ewes which were heavier as yearlings consistently weaned more average pounds of lambs per ewe year during their lifetimes. The average lifetime lamb production per ewe year, as measured by pounds

of lambs weaned, for the highest quarter, middle half, and heaviest quarter of ewes as yearlings was 55, 60 and 69 pounds for Rambouillets; 62, 68 and 75 pounds for Corriedales; 63, 77 and 78 pounds for Columbias; and 71, 81 and 87 pounds for Targhees. (Weaning weights are taken when ram lambs must be removed from ewes at about 130 days of age and are not market weights.) These differences indicate the importance of body weight as a factor in the selection of range ewes.

Although there were definite breed differences in the level of lamb production there was little variation in the difference between the lightest quarter and the heaviest quarter of ewes as yearlings in lamb production among breeds. These differences ranged from 13 to 16 pounds of lambs weaned per ewe year. In other words, selection on yearling body weight would have about the same effectiveness for increased lamb production in each of the breeds studied.

Face Covering in Range Sheep:

(See paper immediately following this report.)

Inheritance of Skin Folds in Rambouillets:

Data taken from weanling offspring in 1940 indicate that continued progress is being made in the elimination of heavy skin folds. Columbia and Corriedale weanling lambs were practically entirely free from folds with only one percent showing moderate neck folds. About 70 percent of the Targhee weanling lambs were free from neck folds. About 59 percent of the Rambouillet weanling lambs were smooth or had only a few neck folds. Selection for smoothness or absence of heavy folds is being continued.

of lambs weaned, for the highest quarter, middle half, and lowest quarter of ewes as yearlings was 55, 64 and 69 pounds for Rambouillets; 60, 68 and 72 pounds for Corriedales; 68, 77 and 81 pounds for Columbias; and 73, 81 and 87 pounds for Targhees. (Weaning weights are those which lambs [illegible] at about 130 days of age and are not actual weights.) These differences indicate the importance of early culling as a factor in the production of range sheep.

Although there were [illegible] breed differences in the level of lamb production [illegible], [illegible] differences between the highest quarter and the [illegible] quarter of ewes as yearlings in lamb production [illegible]. These differences ranged from 28 to 40 pounds of lamb weaned per ewe yearly. In every breed, [illegible] of yearlings [illegible] [illegible] for increased lamb production in [illegible] of the lowest quartile.

<u>Lamb Production in Range Sheep</u>

(See other investigations in collaboration with [illegible].)

<u>[illegible] of [illegible] in [illegible]</u>

[illegible] Montana University in 1950 [illegible] [illegible] [illegible]. [illegible] 77 percent of [illegible]. About 45 percent of [illegible] [illegible].

Inheritance of Horns in Range Sheep:

Progress in this project consisted of the collecting of data on the presence of horns, scurs, horn knobs, or the polled condition on all weanling lambs in the fall of 1940. These data indicate continued success in the elimination of the factor for horns in the Columbias and Targhees. One percent of the Columbia ram lambs had horns, 26 percent had scurs, and 73 percent were polled as compared with 8, 28 and 64 percent respectively for weanling ram lambs in 1939. Likewise with the Targhee ram lambs, 5 percent had horns, 43 percent had scurs, and 52 percent were polled as compared with 9, 76, and 15 percent, respectively, for weanling ram lambs in 1939. These changes show that rapid progress is being made in eliminating the horned factor from these breeds.

Inheritance of Brown Color in Range Sheep:

Observations of the presence of brown color on the face or legs at lambing and weaning time have been continued. In general the percent of weanling lambs with brown color was slightly less in 1940 than in 1939. The percentages were 30, 25, 14 and 10 for the Corriedales, Targhees, Columbias and Rambouillets, respectively, in 1940 as compared with 37, 25, 17 and 12, respectively, for 1939.

Occurrence of Abnormal Lambs:

The proportion of abnormal lambs born in 1941 was 1.9 percent which was identical with the proportion born in 1940. A few deformed lambs were observed but the majority of abnormalities consisted of black spots. These occurred more often on the face and legs than in other portions of the body. The proportion of abnormal lambs was again higher for the crossbred lambs

than for Rambouillet lambs.

Milking Ability of Range Sheep:

Comparisons have been made of ratings of milking ability of range ewes at lambing time with the resulting lamb production for ewes lambing in 1940. Ewes were divided into 5 classes according to their estimated milking ability which was described as very good, good, fairly good, fair and poor. Estimates were based on the apparent fullness of the ewe's udder and of the amount of milk the lamb was apparently getting. Results have been summarized on 604 of the ewes observed in 1940. About 57 percent of the ewes were rated as very good or good, 23 percent as fairly good, 16 percent as fair and 4 percent as poor.

Birth weights generally decreased as the milking ability of the ewes was rated lower. This was probably due to a considerable extent to the milk the lamb had already taken when the weight was recorded. Weaning weights followed the same trend as birth weights but were not as consistent. These comparisons were made separately for single and twin births.

As the rating of milking ability improved the proportion of ewes with twins decreased. The percent of lambs weaned of lambs born was generally higher for the ewes with better ratings on milking ability. These ratings appear to be fairly consistent with the growth and survival of the lamb and would appear to have some value for selection purposes. More extensive data are being summarized.

Length of Gestation:

Summaries of data from nearly 2500 gestation periods in range sheep

are nearly complete. These periods ranged in length from 141 to 159 days. Rambouillets had the longest gestation periods with an average of slightly over 151 days and the Columbias had the shortest with an average of about 148 days. There was little difference between the Corriedales and Targhees with an average of about 149.5 days. Preliminary results indicate considerable annual variation in the length of gestation within breeds.

It appears that ewes which had shorter lengths of gestation had been bred later than ewes which had longer gestation periods. This tended to shorten the lambing season. Rambouillet ewes having an average length of gestation of 148 days had an average breeding date of December 12, and an average lambing date of May 9 while those with an average length of gestation of 154 days had an average breeding date of December 10 and an average lambing date of May 13. This trend was quite definite. The rams were with all of the ewes over the same period of time.

There was a fairly constant though slight increase in the length of gestation with advancing age. Ewes which were 8 and 9 years of age had an average gestation period of nearly 2 days longer than 2 and 3 year old ewes. Within age groups the gestation period resulting in a single birth was longer than that resulting in a twin birth. The average difference was about 0.6 of a day.

There appeared to be no differences in the length of gestation which could be attributed to the sex of the lamb or lambs born.

There was a definite increase in the birth weight with increase in the length of gestation. This increase was, in general, consistent with the rate of gain to be expected immediately after birth. The rate of survival was slightly higher with longer gestation periods. A study

is under way, using this data, on the factors affecting birth weight in range Rambouillet sheep.

Reproductive capacity of rams as indicated by semen tests:

Semen tests were made on 128 rams of which 102 were used in breeding. All except 3 of the 102 rams sired living offspring. These 3 rams were suspected of being sterile but were used for a short time because of the desirability of obtaining offspring from them if possible. Of the remaining 99 rams, 96 sired normal lamb crops with an average of 91 percent of the ewes becoming pregnant.

A total of 24 rams were judged to be unfit for breeding as a result of semen tests. In addition 3 rams which gave satisfactory results from semen tests proved to be of low fertility, although 55 percent of the ewes with which they were mated became pregnant. One of these rams sired a normal lamb crop during the first part of the breeding period and one other ram sired a normal lamb crop during the latter part of the breeding period. This illustrates a difficult problem in predicting fertility from semen tests as it is impossible to predict what changes may occur during the breeding period. These rams received no grain prior to the test nor during breeding. This year some grain will be fed prior to breeding.

A total of 407 ejaculates were examined for volume of semen, motility, concentration, and morphology of spermatozoa. Concentration, motility and morphology of spermatozoa, and the total number of spermatozoa ejaculated in 30 minutes were given emphasis in predicting fertility. Rams from which over 95 percent of the ewes became pregnant produced about 50 percent more spermatozoa in a 30 minute trial than rams from which less

than 85 percent of the ewes became pregnant.

It is estimated that if semen tests had not been used in selecting rams for breeding that the percent of ewes which became pregnant would have been reduced by at least 10 percent.

Collection of Ram Semen:

Studies were made on the effect of variations in the technique of electrical stimulation of ejaculation in rams on the quantity and quality of semen produced. Over 300 collections were made from 6 rams over a two month period. A uniform number of 7 stimulations were used for each collection. Constant current transformers were used to produce currents of from 10 to 150 milliamperes. Less than 50 milliamperes of current usually produced small numbers of spermatozoa while currents of over 110 milliamperes often resulted in the contamination of the semen with urine. A current of 90 milliamperes appeared to produce the best results.

Slight variations in the position of the lumbar or rectal poles produced no definite effect. A two second stimulation followed by an 8 second rest period appeared to result in the ejaculation of more spermatozoa than stimulation periods of 5 seconds or more.

Semen was obtained in only a very few cases which was equal to normal ejaculates in numbers or quality of spermatozoa. Considerable variation in semen produced by the same ram with the same method were found.

Lifetime Wool Production as It Compares with Other Lifetime Production Factors:

A study was made of the lifetime wool and lamb production of 118 "Ramb" series Rambouillet ewes. These were divided into two groups, name-

ly those that sheared a lifetime average of less than 9 pounds of wool known as group 1, and those that sheared an average of nine or more pounds as a lifetime average known as group 2.

Group	No. of ewes	Birth wt. of these ewes (lbs.)	Av. birth wt. of their lambs (lbs.)	Lifetime av. fleece wt. (lbs.)	Av. yrlg. wt. after shearing (lbs.)
1	18	9.0	10.00	10.4	81
2	100	9.5	11.00	11.2	93

Total fleeces 853. Total lambs 788.
Lifetime average per ewe about 6.6 lambs
and about 7 fleeces.

A further analysis was made of these ewes to determine what the result would have been had the ewes been culled which in any year produced less than 9 lbs. of wool. This would have removed ewes which during their lifetime actually produced 153 fleeces with a yearly average weight of 10.4 pounds. The average lifetime average for all other ewes was 11.2 pounds. It is well to have more than one year's fleece record before

Russian Olives, Black Birch, and Dogwood are
attractive and useful wind shelters

culling for wool production. It appears that there is considerable agreement in lamb and wool production, and size of ewe. The heavier producing ewes were appreciably larger as yearlings than the lighter producing ewes.

Influence of Lamb Production on Fleece Weight:

Method I:

Columbia ewes that had remained in the flock 5 years or more were arranged in 3 groups:

Group (a) ewes having 1/2 to 2-1/2 lambs during first 4 lambing years
Group (b) ewes having 3 to 4-1/2 lambs during first 4 lambing years
Group (c) ewes having 5 to 7 lambs during first 4 lambing years

Explanation:
1/2 lamb - ewes giving birth to 1 lamb but not weaning it
1 lamb - ewes giving birth to 1 lamb and weaning it
1 lamb - ewes giving birth to 2 lambs but not weaning them
1-1/2 lambs - ewes giving birth to 2 lambs and weaning 1

The 2-5 year average fleece weight compared to the adjusted yearling fleece weight.

It was found that there was only a slight advantage in the 2-5 year average fleece weight of group (a) over groups (b) and (c) and that groups (b) and (c) produced practically the same quantity of grease wool. However the adjusted yearling fleece weights indicated that group (b) produced approximately .25 pounds less wool than group (c) as yearlings while group (a) produced approximately .25 pound less wool than group (b).

Group (a) (1/2 to 2-1/2 lambs) increased its 2-5 year average wool production by 1.72 pounds of wool over its adjusted yearling fleece weight, group (b) (3 to 4-1/2 lambs) increased its 2-5 year average fleece weight

by 1.30 pounds over its adjusted average yearling fleece weight and group (c) (5 to 7 lambs) by 1.07 pounds. The interesting feature is that the group of ewes producing 5 to 7 lambs had the highest average yearling fleece weight.

This information tends to substantiate the general impression that the heaviest shearing yearling ewes may likewise be the heaviest lamb producers or the most useful ewes.

Method II:

Columbia ewes that had remained in the flock 5 years or more were arranged in 2 groups as follows:

A. Ewes weaning lambs the first lambing year
B. Ewes naturally dry or those that gave birth to a lamb or lambs but did not wean any

The 2 and 3 year fleece weights and fleece lengths for groups A and B were averaged for each age group. A straight average was then obtained of the averages for each age group. Group A produced .66 pound less wool and had .17 inch less staple length than group B.

Wool Studies

Clean Yield Determinations:

Approximately 1200 wool samples and 45 whole fleeces have been scoured during the 1941 fiscal year. The percentage yield in the small sample has been used in determining the total clean yield of dry wool produced by each sheep.

The table on the next page presents a summary and range for wool characters in the 1940 yearling ewes.

Summary and Range for Wool Characters for 1940 Yearling Ewes

Fleece Characters	Rambouillet			Targhee			Corriedale			Columbia		
	Low	High	Mean	Low	High	Mean	Low	High	Mean	Low	High	Mean
Fleece weight (grease) lbs.*	5.10	14.40	9.80	7.60	16.90	11.65	7.10	14.90	10.58	8.83	16.85	12.26
Fleece weight (clean) lbs.	1.56	6.30	3.28	2.35	7.03	4.78	2.88	6.38	4.49	3.47	8.30	5.66
Clean yield (%)	21.25	48.15	33.78	30.94	54.81	41.00	31.35	55.11	43.25	33.25	57.15	46.13
Staple length (cms.)*	4.6	9.9	6.81	6.7	12.9	9.3	6.9	13.2	8.49	7.5	15.0	10.4
Density index**	1.3	3.1	2.06	1.4	3.4	2.15	1.3	2.9	1.91	1.3	3.0	2.16
Fineness side (microns)	16.6	24.4	19.91	19.0	26.4	22.00	17.9	28.0	22.46	19.8	32.7	25.83
Variability side (std. dev.)	1.5	7.5	2.87	1.5	9.2	3.70	2.2	7.1	4.48	3.0	8.7	5.01
Fineness thigh (microns)	18.0	26.0	21.93	20.0	30.4	24.50	17.1	34.2	25.02	22.6	37.3	29.90
Variability thigh (std. dev.)	2.5	14.1	4.74	2.5	9.6	7.21	3.5	8.9	6.13	3.9	11.9	8.25

(*) Not adjusted to 365 days growth

(**) The density index of wool for fleeces of sheep is the weight in hundredths of a gram of clean, dry wool per cubic centimeter of growing staple.

Clean weights and clean yield are based on "clean bone dry wool" determinations.

Reference is made to the foregoing table relative to fleece weights. With a mean grease fleece weight of 9.80 lbs. for the Rambouillet yearling ewes, only 8 fleeces were less than 7 pounds.

In the Targhee breed only 8 fleeces were below 9 pounds and 7 were 14.5 pounds or above with a large grouping around the mean of 11.65 pounds. In the Corriedale breed there 10 fleeces below 9 pounds and 2 above 14.5 pounds with a mean of 10.58 pounds. In the Columbia breed there were 3 fleeces below 9 pounds and 9 fleeces above 14.5 pounds with a mean of 12.26 pounds.

The range for grease and clean yield is rather wide, but in a breeding program this may be expected where nearly all ewe lambs are saved and evaluated as yearlings in order to get progeny test data. The extremes represent the segregates that occur. The low producers of which there are not so many are subject to culling before the breeding season.

Long Staple Inheritance:

Sheep being bred and designated as pen 21 have demonstrated the ability to transmit the long staple character to their offspring. In comparing these with 268 Rambouillet yearling ewes in the progeny test series the following results stand out as being important:

Average of Progeny for Special Research Lines*
(Yearlings 1940)

	No. of head	Grease wt. of fleece (lbs.)	Clean wt.** (lbs.)	Staple length (cms.)	Staple length (ins.)
Pen 21	16	9.55	3.81	6.78	2.67
All others	252	9.15	3.09	5.70	2.24

(*) Adjusted to 365 days growth.
(**) Bone dry basis.

The added fleece length has considerable influence on the value of wool when analyzed on a clean basis. With only a .4 lb. difference in the grease fleece weights, pen 21 produced .72 pound more clean wool than the other progeny studied. When this type of wool is quoted @ $1.06 - $1.08 (July 8, 1941) a clean pound Boston, there is approximately .75 to .80 cents greater income per fleece in favor of the longer staple wool, whereas, the difference in favor of the added .4 lb. for the fleeces in grease amounts to about 15 cents per fleece when these fleeces are sold at the same price in the grease without regard to shrinkage differences. (figured on basis of .37 cents in grease.)

This shows clearly that wool should be sold on its merits. If it is not, then there is no reward for the production of cleaner wools due to staple length.

A Comparison of the Clean Yield for Body Sorts with the Entire Fleece:

Five fleeces each from Rambouillet and Columbia yearlings were used to determine the clean yield in each of 8 body sorts. The sheep were randomised in both breeds. Each body sort area was marked with chalk to correspond with anatomical locations before the sheep was sheared, and after being shorn the fleece was spread on a fleece sorting table and the various body sorts made. These samples were dusted in a small type fleece duster and scoured by the regular emulsion process at the Western Sheep Breeding Laboratory, Dubois, Idaho.

Clean yield results in the Rambouillet breed for breech, back and belly sorts are in very close agreement with the entire fleece. In the various sorts the breech was the closest in agreement (38.1%) with the entire (38.3%) yield, or a difference of only .2%. Results for the Columbia

fleeces show the side, shoulder and breech to be in closest agreement with the entire fleece yield. The side had an average clean bone dry yield of 44.2% which compares closely with the entire yield of 43.0%. Fineness of fiber for the various body sorts derived from carded samples did not appreciably affect the clean wool yield. These are preliminary results and the study is being continued.

Percentage by Weight of Total Half Fleece and Percentage Bone Dry Clean Yield for Fleece Sorts in Yearling Ewes by Breed

Body fleece sorts	Percentage fleece sort is of total 1st half fleece		Bone dry clean yield of wool	
	Rambouillet (percent)	Columbia (percent)	Rambouillet (percent)	Columbia (percent)
Shoulder	11.3	13.7	41.3	44.4
Side	19.0	17.5	41.0	44.2
Back	10.9	11.2	37.7	50.8
Belly	7.8	9.1	39.2	41.3
Neck	18.0	17.1	40.2	48.1
Breech	19.8	17.3	38.1	44.5
Tags	5.8	5.5	19.9	21.5
Remainder	7.4	8.6	40.9	36.0
	100.0	100.0		
Total 1st half	48.6	47.6	38.6	43.5
Total 2nd half intact	51.4	52.4	38.0	42.6
Entire fleece			38.3	43.0

The clean yield for the first half of each fleece sorted was very close to the second half kept intact and also to the yield for the entire fleece. This indicates that for experimental purposes where comparisons with body sorts, or comparisons with various sampling methods by splitting the fleece in half, it is necessary to scour only one-half fleece. This practice eliminates a great deal of laborious scouring.

This study is being continued in more detail by splitting each

body sort into zoned areas for each sheep. The amount of wool for each zone was approximately 35 grams. The number of zones for each of the 8 body sorts was determined from previous data. This study is designed to furnish data to determine the method of sampling that will yield the maximum agreement in small samples, reduce variation in percentage yield to the minimum between and within areas from the same fleece and that will show what proportion the regular small side sample is to the side body sort and how much the error can be reduced by larger samples.

It will give the percentage clean yield for anatomical locations by zones on a sheep for the entire one-half fleece which should aid in determining sampling procedures in breeding programs and commercial sampling techniques.

Cooperative work on body fleece sorts of five animals from each of four breeds for three consecutive years will be summarized when final results are obtained on the 1941 fleeces.

Cooperative Commercial Shrinkage Results:

In the course of other cooperative fleece investigations with the Agricultural Marketing Service on wool from this Station the following results were available: 66 fleeces each or a total of 264 fleeces from the Rambouillet, Targhee, Corriedale and Columbia breeds representing ewes two years of age and older were selected for this study from the 1940 clip. Fleeces were selected by randomising each band to insure representative sampling. 33 were divided into the finest and 33 into the coarsest for each breed, making a total of 8 scouring lots, that were scoured by the Agricultural Marketing Service, Washington, D. C. The sheep were managed

and operated under conditions typical of the Intermountain range for this part of Idaho.

The results on the fleeces by lots are as follows:

	Approximate U. S. numerical grade	Yield of dry* clean wool (percent)	Average yield* by breed (percent)
33 finest Rambouillet	70's-80's	34.1	34.4
33 coarsest Rambouillet	60's-64's	34.6	
33 finest Targhee	62's-64's	35.4	36.7
33 coarsest Targhee	58's-62's	38.0	
33 finest Corriedale	62's-70's	41.0	41.4
33 coarsest Corriedale	56's-60's	41.7	
33 finest Columbia	56's-60's	41.8	43.8
33 coarsest Columbia	48's-50's	45.8	

(*) Corrected to 12% moisture in grease and scoured wool

In every case the finest wool for a breed yielded a smaller percentage of clean dry wool than the coarsest one of that breed, although the difference was slight in the case of Rambouillets and Corriedales.

Results give the clean yield rank for the 1940 wool from the four breeds of sheep that was produced under range conditions from June 1, 1939 to June 1, 1940 in the following order for highest clean yield: Columbia, Corriedale, Targhee and Rambouillet. This order is also the same from the coarsest breed to the finest breed.

These results substantiate the belief that finer wool has a lower clean yield than the coarser wool produced under the same conditions.

Moisture tests were made at this Station on side samples of wool from the above fleeces. The wool samples were kept in moisture proof containers until June 25, 1940, at which time the moisture and scouring determinations were made. Fleeces from which the above samples were taken were sent to the Agricultural Marketing Service laboratory, Washington, D. C., in a regulation size wool bag immediately after shearing in June but

the exact time of moisture and scouring determinations is not known. The samples were taken during favorable weather conditions and show an average moisture content for the wool at the Agricultural Marketing Service laboratory of 5.67% and on wool from the same fleeces at the Western Sheep Breeding Laboratory, an average of 9.19% or a mean difference of 3.52% greater moisture content for the wool kept at this Station. The difference in moisture content of wool at this Station and after it reaches the Agricultural Marketing Service laboratory will be further observed.

Percentage Moisture in Grease Wool

Breed	A. M. S. laboratory (percent)	W. S. B. L. laboratory (percent)
Rambouillet	5.58	9.19
Targhee	5.29	8.64
Corriedale	5.78	9.77
Columbia	6.04	9.15
Mean	5.67	9.19
Mean difference at Western Sheep Breeding Laboratory		3.52

Fiber Fineness and Variability Studies:

A total of approximately 6,194 wool samples have been evaluated and calculated for fineness, variability and medullation during the past year. This includes all rams, yearling ewes and all ewes four years and older that are in the experimental flocks. The fleeces from all ewes up to four years of age had previously been cross-sectioned. We now have fineness and variability data on every sheep in the flock that is used in the breeding program. Hereafter it is the plan not to cross-section ewes in the flock over one year of age, except as special studies may be organized, as the data is now available on all of them, hence yearling ewes only will be cross-sectioned. Rams are cross-sectioned each year.

Results on Wool from aged Ewes:

Data on the fineness and variability of wool in the four year and older ewes was accomplished by taking samples from the right side and thigh at shearing time. The samples were cross-sectioned and evaluated by the rapid comparator method.

Mean Diameter and Variability of Wool for
Ewes 4 Years of Age and Older in 1940

Breed	Mean diameter	Variability	
	Average for side & thigh	Average for side & thigh	
		Standard deviation	Coeff. Var.
	(microns)	(microns)	(percent)
Rambouillet	21.0	3.9	18.4
Targhee	23.5	4.7	20.0
Corriedale	23.7	5.2	21.9
Columbia	27.4	6.0	21.9

These determinations were necessary in order to have basic data on ewes from which progeny tests are studied.

Development of a Rapid Comparator Method for Determining Fineness and Variability in Wool:

A rapid method for estimating wool fineness and variability has been developed in the wool laboratory which reduces by one-half the time required for determining fineness and variability on the experimental flocks. This method involves the direct comparison with the micro-projection of a cross-section of wool fibers with known standards, on a 35 mm. film strip, which have been developed for this purpose.

Details of this method were published in the Proceedings of the American Society of Animal Production, 1940, pages 161-168.

Film strips with wool standards ranging from 16 to 42 microns or

80's to 36's have been made available for agricultural experiment stations of the Western States. Some of these stations have already requested the loan of a film strip. This is an important step in standardising wool research studies in the range states.

Method of Expressing Medullation in Wool:

A method for expressing the percentage of medullated fibers from fleece samples has been developed. This is readily applicable to studies in large numbers of sheep and by means of which they can be appraised on a comparative basis. This method is described in A. H. D. No. 41, May 1941, a copy of which is included in this report.

Hairy Birth Coat in Lambs:

The 24 lambs with varying degrees of hairiness selected in 1940 and sampled each month, with a view of determining the persistence and significance of the hairy birth coat, have been observed for 14 months. Some of the lambs lost their hairy appearance during the first few months of life. In other cases hairiness persisted throughout the first year. Some of these specimens are being carried into the second year for further study and observation. Studies to develop methods of detecting the difference in hairiness which persists from that which is soon lost are being continued. A group of 27 lambs born in 1941 have been selected for further study on the significance of the hairy birth coat.

All lambs in the flocks were scored for hairiness in the fleece at the time of docking for the second consecutive year, but results are not available for reporting at this time.

Scouring and Manufacturing Studies in Cooperation with the Agricultural Marketing Service, Federal Prison Industries and the Bureau of Home Economics:

Twenty-two bags of wool - 5 from each of 4 breeds, namely Rambouillet, Targhee, Corriedale and Columbia and one bag from the line of Rambouillet breeding with long staple inheritance and one bag from the line of breeding with a shorter staple inheritance are being scoured by Eavenson and Levering, commercial wool scourers, Camden, New Jersey.

After scouring to determine clean yield for each lot, these wools are to be manufactured into different kinds of cloth and blankets. Tests are to be made as to the kind or type of wool best suited for each purpose. Various manufactured articles are to be tested for durability and wearing qualities.

A Study to Determine the Most Representative Area for Sampling in Each of the Rambouillet, Targhee, Corriedale and Columbia Breeds:

This problem involves a study of wool for fineness, variability, clean yield and density index from eight locations in 15 sheep each of 4 breeds. Sample locations were at top of withers, middle of back, just anterior to the dock, middle of scapula, middle of side, over point of hip and on the belly. This problem was started in June 1941.

Cooperative Projects with Collaborating Stations

Arizona (A.H. 103.5):

Title: A study of the adaptability of the Targhee breed for lamb production and range ewe replacement in Arizona.

Status: On June 1, 1940 three Targhee rams, 1203T, 1296T and 1385T, were loaned to the Arizona Station under the direction of Mr. E. B. Stanley, Head, Department of Animal Husbandry. These rams were placed in the flock of K. P. Pickrell, Paulden, Arizona (Hdq. Phoenix).

While the first crop has been born to these rams, there is no information available yet on the main objective, namely their value as replacement ewes.

California (A.H. 105.6):

Inasmuch as this project involved primarily the loan of Merinos to California this project has been inactive since the Merinos were sold in 1940 to go to that state.

Colorado (A.H. 106.6):

Title: Crossbreeding range ewes and influence of crossbreeding in fattening lambs.

Status: Targhee ram No. 1518T was loaned to the Colorado Station November 6, 1940 for use in the above project. The first lamb crop was produced in April and May, hence the only data available at this time is the birth weight of the lambs and the sex. The data and results of this project will accumulate as the study progresses.

Oregon (A.H. 138.2):

Object: To test a Laboratory Rambouillet ram on Oregon Experiment Station ewes to determine his value when used in an outcross. No. 3663R

was used for this purpose. He was shipped to the Eastern Oregon Experiment Station October 3, 1939 and was returned to this Laboratory May 30, 1941. The data are as yet incomplete.

Montana (A.H. 127.17):

Title: The development of range sheep through outcrossing and progressive backcrossing to Columbia rams.

Status: Eleven Columbia rams were loaned to the Montana Experiment Station on November 10, 1940. These were used in the flock of Dr. H. C. Gardiner, the Montana Station's cooperator.

Up to this time a report is available on the matings to five of these rams as follows:

2726K	sired	98 lambs	3104K	sired	93 lambs
3292K	"	98 "	3043K	"	78 "
3310K	"	64 "			

These lambs were judged to be a "uniform lot". "There were very few that seemed to be either too fine or too coarse". - H. C. Gardiner. More complete data will be available later this year.

Wyoming (A.H. 1.38 - 155.12):

Object: To determine the value of a Laboratory ram in an outcross on University of Wyoming ewes. If this effort appears successful, it is the object to develop an inbred line with this foundation.

Status: Rambouillet ram No. 3835R was loaned to the Wyoming Experiment Station in the fall of 1940. From the 14 ewes to which he was mated 19 lambs were weaned at an average of 83 lbs. The average birth weight was 10.3 pounds. There were 3 sets of twins and one set of triplets. The heaviest lamb, a single, at weaning weighed 107 pounds. On May 19 or at

weaning 2 lambs were described as excellent, 16 as good and 1 as fair. One lamb was described as "very wrinkly" and one as "little wrinkly". No comment appears in the report on the other lambs with respect to wrinkles. Two lambs were described as "hairy" at birth and one at weaning time.

Yearling Ewes after Shearing
(Pictures not taken same distance from camera)

Targhee

Weight after shearing 100 lbs. Clean weight of wool adjusted to 12 months 3.97 lbs. This ewe is pulling back and shows a much more wrinkled condition than actually obtains. Her shoulder also appears cramped because she is tense.

Columbia

Weight after shearing 119 lbs. Clean weight of wool adjusted to 12 months 5.87 lbs.

Rambouillet

Weight after shearing 85 lbs. Clean weight of wool adjusted to 12 months 3.21 lbs.

Face Covering in Range Sheep

Many range sheep, particularly those of Rambouillet breeding, have wool covering over most of the face. This covering of wool on the face has usually been associated with wool covering on the legs, which may have some protective value. While the actual wool grown on the face and legs adds little if any value to the fleece, it has long been thought that covered faces were associated with a heavy weight of fleece. In recent years it has become apparent that heavy covering of wool on the face was not necessarily indicative of heavy fleece weight. Spencer et al (1) published data on wool production in 1928 showing that Rambouillet ewes with the barest faces had heavier fleece weights both unscoured and scoured than those having heavily covered faces.

Range sheep producers in general favor a type with an open face. Sheep with heavily covered faces have to be clipped around the eyes at least 2 or 3 times per year in order that they may see to feed. This involves some expense and causes considerable annoyance. Many ewes with heavily covered faces need to be clipped around the eyes more often than others. These ewes may be wool-blind for part of the year and consequently do not do so well as others. They are more apt to be lost from the band and may die because of lowered resistance and vitality due to partial starvation or lack of water.

Wool on the face is undesirable where lambs go into the feed lot. Wool blind lambs are timid in the feed lot and are probably not able to feed as well as lambs with open faces. Feeders of western lambs prefer lambs with open faces and find that in the case of those with covered faces it is necessary to keep the wool around the eyes clipped in order to obtain good gains.

Wool grown on the face and legs is of questionable commercial value. This wool may be short, is often stained and is apt to be contaminated with burrs, foxtail, chaff, and other foreign matter. Second cuts are often made on the face around the eyes and ears. Wool sheared from the face is apt to be loose and is often lost from the fleece or left with the tags.

Literature on the inheritance of head furnishings has been reviewed by Miller (2). General agreement on the mode of inheritance of face covering is lacking. Ritzman (3) studied crosses of the Rambouillet with the Southdown, Hampshire, Oxford, and Dorset. He found that there was no simple dominance either for heavy, light, or for entire lack of wool on the face, ears, and on the lower part of the legs. He also found a general correlation between fineness of wool and the degree to which it covers the extremities.

The objects of these investigations were to determine the relationship of face covering to factors of economic importance in sheep production; to obtain information on the variation of degree of face covering; to learn more concerning the inheritance of face covering; and to formulate a breeding program for rapidly fixing the open face character in range sheep.

Material and Methods

This study involves records of scores for face covering and wool and lamb production of sheep in the Rambouillet flock of the Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station, Dubois, Idaho. Data on 389 yearling Rambouillet ewes born in 1938 and 1939 from 21 sires

having ten or more daughters in both years were used. Data on offspring from Rambouillet rams crossed with unregistered Corriedale ewes and from Targhee matings were also used. Weanling data were taken from all Rambouillet lambs born in one band in 1938, 1939 and 1940. In addition the relation of face covering to lamb production was determined from lifetime data on Rambouillet ewes born from 1925 to 1934, inclusive.

Wool covering on the face was scored as follows: "1" not covered beyond the poll, "2" covered to the eyes, "3" covered slightly below the eyes but with open face or not subject to wool-blindness, "4" covered below the eyes, but not entirely covered and subject to wool-blindness, "5" almost or entirely covered and subject to wool-blindness. The latter three of these scores are most common in Rambouillets and are illustrated in figure 1. Yearling scores were used for dam-daughter comparisons. Rams were scored each year and the score most representative of the lifetime scores was used.

Other measures and scores include body weight in pounds which was taken just after shearing at yearling age. Unscoured fleece weight was taken on the shearing floor to the nearest .05 pound. The scoured weight of fleece was determined by multiplying grease weight by percent of yield. Percent of yield is the percent of bone dry, clean wool scoured from a representative sample of the fleece. Fleece length was measured at the middle of the side to the nearest 0.2 centimeter. Neck folds were scored as follows: "1" no folds, "2" very few folds of small or moderate size, "3" folds of moderate number or size, "4" heavy folds of moderate or large number, "5" completely covered with heavy folds. Fineness was determined by estimating mean diameter from projected cross-sections.

Scores for face covering and neck folds and measurement of fleece

Figure 1. Photos of faces of Rambouillet sheep showing degrees of wool covering.

A to C - open faces, scored as 3;
D to F - partially covered faces, scored as 4;
G to I - covered faces, scored as 5.

length were taken by each of a committee of three qualified judges and averages of the three were used for the values assigned to each animal. Values in the upper 1/3 and lower 1/3 of each score have been indicated by plus and minus signs and have been assigned a minus .33 and plus .33, respectively. Thus, 3-plus has a numerical value of 2.67 and 3-minus a numerical value of 3.33. Measurements of unscoured and scoured fleece weight and fleece length have been adjusted to 365 days growth.

Determination of lamb production has been based on the pounds of lambs weaned per ewe year. This was obtained by dividing the total weight of lambs weaned at about 130 days by the number of years the mothers were in the flock.

All ewes included in this study which were subject to wool-blindness have had the wool clipped from around the eyes several times per year so that differences between those subject to wool-blindness and those not subject to wool blindness have come about in spite of this corrective treatment.

Results

The various degrees of face covering most common to range sheep are illustrated in figure 1. The range sheep with practical face covering is usually thought of as one with wool to the eyes but with an open face or one not subject to wool-blindness as illustrated for a score of "3". Faces which are bare to the poll and back of the eyes, scoring "1" and "2", respectively, are also classified as open-faced but are very rare in the Rambouillet flock studied here. However, these types are often found in range sheep, usually as a result of crosses with bare-faced sheep. Wool cover-

ing on the face sufficient to make the sheep subject to wool-blindness but not entirely covering the face is given a score of "4" and this type is referred to as having a partially covered face. Covered faces are those with wool practically covering the face entirely and are given a score of "5".

The majority of the Rambouillet yearling ewes included in this study were subject to wool blindness. Only 10.5 percent had open faces, 34.2 percent had partially covered faces and 55.3 percent had covered faces. Yearling ewes born in 1938 and 1939 have been combined for this study as there was practically no difference between the two groups in regard to face covering.

Limited observations on the relation of wool covering on the face to wool covering on the legs have been made and the relationships are illustrated in figure 2. Rambouillets with more covered faces tended to have slightly more wool on the legs although those with open faces had wool on the legs well below the knees and hocks.

Relationships of face covering to fleece production are shown in table 1. There was a slight tendency for increased unscoured fleece weight to be associated with more wool covering over the face but much of the difference disappeared when fleece weights were considered on a scoured basis. There was no definite relation between face covering and fleece length or fleece fineness. Correlation coefficients between face covering score and unscoured fleece weight, scoured fleece weight, fleece length and fleece fineness were .12, .01, -.04 and .07, respectively. The coefficient between face covering and unscoured fleece weight was barely significant.

There was a tendency for lighter body weights to be associated

Figure 2. Photos of Rambouillet sheep showing degrees of wool covering of faces and legs.

A and D, ram and ewe with open faces;
B and E, ram and ewe with partially covered faces;
C and F, ram and ewe with covered faces.

with a more covered face. Ewes with covered faces averaged 83.7 pounds, while ewes with partially covered faces averaged 86.1 pounds and ewes with open faces averaged 88 5 pounds at yearling age after shearing. The correlation coefficient between face covering and body weight of -.15, although low, was significant,

Table 1
Relationship of Face Covering with Fleece Production of Yearling Rambouillet Ewes

Face covering	Unscoured fleece wt. adj. to 365 days		Scoured fleece wt. adj. to 365 days		Fleece lgth. adj. to 365 days		Fleece fineness at side	
	No. head	Average (lbs.)	No. head	Average (lbs.)	No. head	Average (cm.)	No. head	Mean diameter (microns)
Open face	41	8.69	38	2.93	41	5.68	19	19.58
Partially covered face	132	8.81	123	2.99	132	5.76	58	19.79
Covered face	215	9.06	182	2.93	215	5.61	116	19.91

There was a very slight increase in degree of neck folds with a more covered face as shown by the correlation coefficient of .11 which was barely significant.

The effect of degree of face covering on lamb production is shown in table 2. These data include the lifetime lamb production of all registered Rambouillet ewes born at this Station from 1925 to 1934 which left the flock because of death, became missing, or were culled for age. Ewes culled for other reasons were not included because more of them had covered and partially covered faces, and these were culled on the average of about a year younger than those having open faces. The ewes with open faces excelled in lamb production over those groups which were subject to wool blindness as shown by an advantage of 6 to 8.5 pounds of lambs weaned per ewe year. This was mainly due to a higher percent of lambs born

and weaned from the ewes with more open faces, although there was also an advantage of nearly a pound in weaning weight. These differences may be attributed both to the detrimental effects of wool-blindness in the ewe and in the lamb, as it will be shown later that open-face ewes are more apt to have open-face lambs and covered-face ewes are more apt to have covered-face lambs. Also these differences occurred in spite of periodic shearing around the eyes of all ewes subject to wool-blindness. More recent data of a limited nature has shown somewhat greater advantage in lamb production for ewes with open faces.

There appeared to be sex differences in face covering as shown in table 3. It was necessary to make this comparison on lambs at weaning age as this was the latest date that comparable populations of rams and ewes

Table 2
Relation of Face Covering to Lamb Production

Face covering	No. of ewes	Average lambing years per ewe	Total lambs born	No. lambs born per 100 ewe years	No. lambs weaned per 100 ewe years	Average weaning weight (lbs.)	Wt. of lambs weaned per ewe year (lbs.)
Open face	117	4.1	570	118	91	70.4	63.9
Partially covered face	138	4.4	670	110	83	69.5	57.5
Covered face	138	4.0	593	107	79	69.6	55.3

were available. All lambs weaned from one band of Rambouillets for the 3 year period of 1938 to 1940 were included. At weaning age ram lambs had more wool covering the face than ewe lambs. The difference between the 2 groups was highly significant. It is possible that the wool covering on the face of a ram grows and develops at an earlier age than on the ewe. Limited observations on rams scored each year of their life for face covering fail to show any definite change with age from the weanling score.

Previous work (4) has shown that ewes have more wool covering on the face at yearling than at weanling age. This work is further substantiated by comparing data in table 3 with the distribution for yearling ewes given in the second paragraph of the results, which shows a shift toward more covered faces in the yearling as compared with the weanling ewe.

Table 3
Sex Differences in Face Covering of
Weanling Rambouillet Lambs

	Male lambs		Female lambs	
Face covering	No.	Percent	No.	Percent
Open face	54	6.5	154	16.3
Partially covered face	336	40.4	498	52.9
Covered face	441	53.1	290	30.8
Total - - - -	831		942	

It has been noted in making selections for breeding that ewes with open faces appeared to be present in greater proportion than rams with open faces. This would support the view that the sex difference is not entirely a result of difference in age of development of face covering. However, rams are selected much more rigidly than ewes and the chances that a Rambouillet ram with an open face will also be acceptable for all other requirements is quite low. In the case of ewes where selection is necessarily very limited nearly all ewes with open faces are retained for breeding and are kept in the flock as long as possible.

In planning a breeding program to increase the open-face character in the Rambouillet flocks it is important first to obtain information on the heritability of the open-face character. The relations between the parents and the offspring are shown in table 4 by the coefficients of correlation and regression. All coefficients are positive and highly signi-

ficant. An estimate of heritability as suggested by Lush (5) may be obtained by doubling the within sire regression of daughters on dams of .22 which indicates that 44 percent of the variance between face covering scores of mates to a sire was due to additively genetic differences between those ewes, including a small part of epistatic differences. There had been some selection for open face among the dams particularly to one sire. There had been practically no selection among the daughters. The daughters of each sire were less variable than their dams.

The correlation coefficient of .14 between sires and dams in table 4, although low, shows a tendency for like to be mated to like. This was probably largely due to the fact that nearly half of the rams included

Table 4
Relation between Parent and Offspring on Face Covering as Indicated by Coefficients of Correlation and Regression

Relationship	Degrees of freedom	Correlation coefficient	Regression coefficient
Daughters on dams	386	.39	.26
Daughters on dams within sires	368	.35	.22
Daughters on sires	388	.39	.62
Dams on sires	388	.14	.34

were related to part or all of the ewes to which they were mated and in one case both ram and ewes were selected for open face. The standard partial regression coefficient of daughters on dams independent of sires was .34 as compared with .35 for daughters on sires independent of dams. The similarity of these beta-coefficients shows that the sire and dam appear to be practically equal in transmitting the factors for degree of face covering to their daughters.

It is recognized that in the animals studied all gradations in face

covering, from a face bare of wool to the eyes to one completely covered with wool occurred. The system of scoring used allows for about 9 to 12 different distinctions in degree of face covering in the type of sheep being studied. While it has previously been shown that face covering score is a repeatable measure as scores taken at weaning were fairly reliable in indicating the face covering score of the yearling animal (4), it must be admitted that a considerable portion of the variance of face covering of dams not due to heredity is probably due to the impossibility of exactly measuring face covering by scores. For this reason many of the comparisons used in this study are based on a rather rough grouping of the animals involved into three classes on a basis of their face covering scores as is illustrated in figure 1.

Data on the results of matings involving sheep with various degrees of face covering are not yet complete. Preliminary observations show that Rambouillets with open faces mated to Rambouillets with open faces yield offspring about half with open faces and half with partially covered faces. Animals with partially covered faces mated with each of the three types produced offspring of all three types, although in every case there were more with covered faces than with open faces. Mating of animals with covered faces with each produced practically all covered faces. It is difficult to determine from these data the number of genes involved in the inheritance of face covering in Rambouillets. It appears that the gene pattern may not be very complicated. This would be particularly true if there are modifying factors present which seems likely in view of the large number of gradations in face covering which exist. These gradations have been minimized in this study due to the simplified groupings which have

been used. Open face appears to have dominance over covered face but the results are inconclusive as yet.

Data on Rambouillet-Corriedale crosses and Targhee matings show that the open-face character of the crossbred type such as the Corriedale is dominant over the covered face of the Rambouillet.

Available records show that the foundation stock for the Rambouillet flock studied here was composed largely of sheep with covered faces. It is not surprising that the process of changing this situation to one in which the majority of sheep will have open faces has been and will be slow. It seems probable that the gene or genes for open face have been quite rare in this flock. Progress should be increasingly rapid as more animals in the flock carry the factors for open face. The heritability of face covering would seem to be sufficiently high that selection could be based largely on the appearance of the face of the animal and that there would probably not be much need for inbreeding or progeny tests. However, the latter might be more essential when a high proportion of the sires have open faces to determine which would breed true for the character.

Summary and Conclusions

1. Variation in face covering in the Rambouillet flock of the U. S. Sheep Experiment Station was described showing a predominance of sheep subject to wool blindness.

2. Little or no relationship was demonstrated between face covering and unscoured and scoured fleece weight, fleece length, fleece fineness, body weight, and neck folds in these data, although there were slight tendencies for ewes with open faces to have lighter unscoured fleece weights,

heavier body weights and fewer neck folds.

3. Rambouillet ewes with open faces had a decided advantage in lamb production, from 6 to 8.5 pounds of lamb weaned per ewe year over ewes subject to wool blindness.

4. Rambouillet ram lambs have more wool covering on the face at weaning time than ewe lambs, although this difference is probably due more to age of development than to a fundamental sex difference.

5. The heritability of face covering was found to be relatively high, as, in general, rams and ewes tend to breed as they look. Rams and ewes appeared equal in their ability to transmit face covering to their offspring.

6. Results of matings show the possibility that inheritance of face covering in Rambouillets may not be very complicated. It is probable that one or more modifying factors are present.

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A. H. D. No. 41. May, 1941

United States Department of Agriculture
Bureau of Animal Industry
Animal Husbandry Division

A RAPID METHOD FOR EXPRESSING MEDULLATION IN WOOL

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Animal-fiber technologists and wool manufacturers have for many years recognized medullation in wool fibers as a defect. However, there is need of a workable method by which the degree of medullation can be expressed with precision and in a manner applicable to sheep breeding programs in which comparative studies are necessary.

Wilson (4) has reviewed the history of medullated fiber research and has developed a macroscopic method of detection. The cross-section method developed by Hardy (1) has also made it possible to detect medullation in wool, and, by making use of the count method described by Hardy and Wolf (2), and by applying the rapid comparator method for determining fineness and variability described by Pohle (3), a method has now been developed by means of which the degree of medullation in wool fibers can be conveniently expressed in percentage.

Materials

In making cross-sections for quality studies of wool at the Western Sheep Breeding Laboratory, Dubois, Idaho, 241 samples showing varying degrees of medullation in wool fibers were selected for use in this study. Photostats were made of these cross-sections, which were later analyzed for fineness and variability as well as for medullation. Medullated wool fibers are very clearly discernible in photostat cross-sections at 500 diameters because the center of the fiber or medulla is white, and the cortex of the wool fiber black. In the microscopic inspection of the cross-sections the medulla is obviously the reverse of this, or black, and the cortex is white.

Basis for Method

Tables 1, 2, and 3 have been compiled respectively for the adjacent, adjacent to loose, and loose degrees of "pack" by using data previously presented by Hardy and Wolf (2). They reported the average number of wool fibers in cross-section for a given mean diameter in microns for a 125 sq. cm. area, magnified at 500 diameters when any one of the previously mentioned degrees of "pack" was used. By knowing the average number of fibers in a 125 sq. cm. area, it is now possible to express degree of medullation in percentage by counting all the medullated fibers appearing inside

of the area, and not touching the area boundaries. To this number were added all alternate medullated fibers that were in contact with the boundaries of the area and lying either outside or inside of the area selected. The total number of medullated fibers are now available for reference to the tables. As an example in table 1, for adjacent pack, if the estimated mean fiber diameter is 22 microns, which, according to Hardy and Wolf (2), contains an average of 104 fibers within a 125 sq. cm. area, and which by actual count shows 13 medullated fibers, then the percentage of medullation can be determined by dividing the number of medullated fibers by the total number of fibers within the area and multiplying by 100 which is in this case 12.5 percent medullation. This is the manner in which the tables were prepared so that it is possible to read directly the percentage for different numbers of medullated fibers.

Application of Method

The cross-section is placed in the micro-projector and a representative area projected onto a receiving screen that contains a 125 sq. cm. rectangular area. In regular routine examination of the cross-section, mean diameter and variability are estimated by the method described by Pohle (3). Then if any medullated fibers are present they are counted in the manner already described and the type of "pack" is estimated. Percentage of medullation is arrived at by referring to the proper table. Thus, if the mean diameter is 22 microns and 13 medullated fibers were counted and the pack was estimated as adjacent, refer to table 1, on the line for 22 microns and the column for 13 medullated fibers which gives the percentage of 12.5 where the line and column intercept.

Test of Method

It is recognized that errors in the percentage of medullation as arrived at by the proposed method might occur due to failure to estimate exactly the mean diameter or degree of "pack." Also it is probable that the number of fibers in the area will vary around the mean which is used in each given case. Therefore, it is necessary to determine if these possibilities actually interfere with the practical accuracy of the proposed method.

A study was made to test the accuracy of determining the percentage of medullation with the method being presented, as compared with the calculated percentage of medullation determined by making actual fiber counts from the photomicrographs of the 241 cross-sections.

By comparing the percentage of medullation arrived at by use of the tables with the calculated, which was based on the actual count, it was found that 80.5 percent of the estimates were within 1 percent of the calculated; 11.6 percent were within 2 percent, and 7.9 were slightly above 2 percent of the calculated. The range of difference between the percentage for the proposed method and calculated appeared to progress as the wool fibers increased in diameter and the medullated fibers increased in number. The mean diameters of the samples studied varied from 18 to 35 microns; the number of medullated fibers in each sample varied from 1 to 52, and the percentage medullation from 0.6 to 91.0. All three types of "pack" were involved.

Table 1

Percentage Medullation in Wool Fibers for 125 Sq. Cm. Area at 500 Diameters for Adjacent (A) Packing

Mean diameter (microns)	Average no. fibers in 125 sq. cm. area	No. medullated fibers in 125 sq. cm. area																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
16	198.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.6	5.1	5.6	6.1	6.6	7.1	7.6	10.1	12.6
17	174.0	0.6	1.2	1.7	2.3	2.9	3.5	4.0	4.6	5.2	5.8	6.3	6.9	7.5	8.1	8.6	11.5	14.4
18	154.0	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.8	6.5	7.1	7.8	8.4	9.1	9.7	13.0	16.2
19	137.0	0.7	1.5	2.2	2.9	3.7	4.4	5.1	5.8	6.6	7.3	8.0	8.8	9.5	10.2	11.0	14.6	18.2
20	125.0	0.8	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0	16.0	20.0
21	113.0	0.9	1.8	2.7	3.5	4.4	5.3	6.2	7.1	8.0	8.9	9.7	10.6	11.5	12.4	13.3	17.7	22.1
22	104.0	1.0	1.9	2.9	3.9	4.8	5.8	6.7	7.7	8.7	9.6	10.6	11.5	12.5	13.5	14.4	19.2	24.0
23	95.0	1.1	2.1	3.2	4.2	5.3	6.3	7.4	8.4	9.5	10.5	11.6	12.6	13.7	14.7	15.8	21.1	26.3
24	87.0	1.2	2.3	3.5	4.6	5.8	6.9	8.1	9.2	10.3	11.5	12.6	13.8	14.9	16.1	17.2	23.0	28.7
25	80.0	1.3	2.5	3.8	5.0	6.3	7.5	8.8	10.0	11.3	12.5	13.8	15.0	16.3	17.5	18.8	25.0	31.3
26	74.0	1.4	2.7	4.1	5.4	6.8	8.1	9.5	10.8	12.2	13.5	14.9	16.2	17.6	18.9	20.3	27.0	33.8
27	69.0	1.5	2.9	4.4	5.8	7.3	8.7	10.1	11.6	13.0	14.5	15.9	17.4	18.8	20.3	21.7	29.0	36.2
28	64.0	1.6	3.1	4.7	6.3	7.8	9.4	10.9	12.5	14.1	15.6	17.2	18.8	20.3	21.9	23.4	31.3	39.1
29	60.0	1.7	3.3	5.0	6.7	8.3	10.0	11.7	13.3	15.0	16.7	18.3	20.0	21.7	23.3	25.0	33.3	41.7
30	56.0	1.8	3.6	5.4	7.1	8.9	10.7	12.5	14.3	16.1	17.9	19.6	21.4	23.2	25.0	26.8	35.7	44.6
31	52.5	1.9	3.8	5.7	7.6	9.6	11.4	13.3	15.2	17.1	19.1	21.0	22.9	24.8	26.7	28.6	38.1	47.6
32	49.0	2.0	4.1	6.1	8.2	10.2	12.2	14.3	16.3	18.4	20.4	22.5	24.5	26.5	28.6	30.6	40.8	51.0
33	46.0	2.2	4.4	6.5	8.7	10.9	13.0	15.2	17.4	19.6	21.7	23.9	26.1	28.3	30.4	32.6	43.5	54.3
34	43.5	2.3	4.6	7.0	9.2	11.6	13.8	16.1	18.4	20.7	23.0	25.3	27.6	29.9	32.2	34.5	46.0	57.5
35	41.0	2.4	4.9	7.3	9.8	12.2	14.6	17.1	19.5	22.0	24.4	26.8	29.3	31.7	34.2	36.6	48.8	61.0
36	39.0	2.6	5.1	7.7	10.3	12.8	15.4	18.0	20.5	23.1	25.6	28.2	30.8	33.3	35.9	38.5	51.3	64.1
37	37.0	2.7	5.4	8.1	10.8	13.5	16.2	18.9	21.6	24.3	27.0	29.7	32.4	35.1	37.8	40.5	54.1	67.6
38	35.0	2.9	5.7	8.6	11.4	14.3	17.1	20.0	22.9	25.7	28.6	31.4	34.3	37.1	40.0	42.9	57.1	71.4
39	33.0	3.0	6.1	9.1	12.1	15.2	18.2	21.2	24.2	27.3	30.3	33.3	36.4	39.4	42.4	45.5	60.6	75.8
40	31.0	3.3	6.5	9.7	12.9	16.1	19.4	22.6	25.8	29.0	32.3	35.5	38.7	41.9	45.2	48.4	64.5	80.6

Table 2

Percentage Medullation in Wool Fibers for 125 Sq. Cm. Area
at 500 Diameters for Adjacent to Loose (AL) Packing

Mean diameter (microns)	Average no. fibers in 125 sq. cm. area	No. medullated fibers in 125 sq. cm. area																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
18	153.0	0.7	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.8	8.5	9.2	9.8	13.1	16.3
19	136.0	0.7	1.5	2.2	2.9	3.7	4.4	5.1	5.9	6.6	7.4	8.1	8.8	9.6	10.3	11.0	14.7	18.4
20	124.0	0.8	1.6	2.4	3.2	4.0	4.8	5.7	6.5	7.3	8.1	8.9	9.7	10.5	11.3	12.1	16.1	20.2
21	112.5	0.9	1.8	2.7	3.6	4.4	5.3	6.2	7.1	8.0	8.9	9.8	10.7	11.6	12.4	13.3	17.8	22.2
22	102.5	1.0	2.0	2.9	3.9	4.9	5.9	6.8	7.8	8.8	9.8	10.7	11.7	12.7	13.7	14.6	19.5	24.4
23	93.5	1.1	2.1	3.2	4.3	5.4	6.4	7.5	8.6	9.6	10.7	11.8	12.8	13.9	15.0	16.0	21.4	26.7
24	85.5	1.2	2.3	3.5	4.7	5.9	7.0	8.2	9.4	10.5	11.7	12.9	14.0	15.2	16.4	17.5	23.4	29.2
25	78.5	1.3	2.6	3.8	5.1	6.4	7.6	8.9	10.2	11.5	12.7	14.0	15.3	16.6	17.8	19.1	25.5	31.8
26	73.0	1.4	2.7	4.1	5.5	6.9	8.2	9.6	11.0	12.3	13.7	15.1	16.4	17.8	19.2	20.6	27.4	34.2
27	67.5	1.5	3.0	4.4	5.9	7.4	8.9	10.4	11.9	13.3	14.8	16.3	17.8	19.3	20.7	22.2	29.6	37.0
28	62.5	1.6	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	32.0	40.0
29	58.0	1.7	3.5	5.2	6.9	8.6	10.3	12.1	13.8	15.5	17.2	19.0	20.7	22.4	24.1	25.9	34.5	43.1
30	54.0	1.9	3.7	5.6	7.4	9.3	11.1	13.0	14.8	16.7	18.5	20.4	22.2	24.1	25.9	27.8	37.0	46.3
31	50.5	2.0	4.0	5.9	7.9	9.9	11.9	13.9	15.8	17.8	19.8	21.8	23.8	25.7	27.7	29.7	39.6	49.5
32	47.0	2.1	4.3	6.4	8.5	10.6	12.8	14.9	17.0	19.2	21.3	23.4	25.5	27.7	29.8	31.9	42.6	53.2
33	44.5	2.3	4.5	6.7	9.0	11.2	13.5	15.7	18.0	20.2	22.5	24.7	27.0	29.2	31.5	33.7	44.9	56.2
34	42.0	2.4	4.8	7.1	9.5	11.9	14.3	16.7	19.1	21.4	23.8	26.2	28.6	31.0	33.3	35.7	47.6	59.5
35	40.0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	50.0	62.5
36	37.5	2.7	5.3	8.0	10.7	13.3	16.0	18.7	21.3	24.0	26.7	29.3	32.0	34.7	37.3	40.0	53.3	66.7
37	35.5	2.8	5.6	8.5	11.3	14.1	16.9	19.7	22.5	25.4	28.2	31.0	33.8	36.6	39.4	42.3	56.3	70.4
38	33.5	3.0	6.0	9.0	11.9	14.9	17.9	20.9	23.9	26.9	29.9	32.8	35.8	38.8	41.8	44.8	59.7	74.6
39	31.5	3.2	6.4	9.5	12.7	15.9	19.1	22.2	25.4	28.6	31.8	34.9	38.1	41.3	44.4	47.6	63.5	79.4
40	30.0	3.3	6.7	10.0	13.3	16.7	20.0	23.3	26.7	30.0	33.3	36.7	40.0	43.3	46.7	50.0	66.7	83.3

Table 3

Percentage Medullation in Wool Fibers for 125 Sq. Cm. Area at 500 Diameters for Loose (L) Packing

Mean diameter (microns)	Average no. fibers in 125 sq. cm. area	No. medullated fibers in 125 sq. cm. area																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
18	151.0	0.7	1.3	2.0	2.7	3.3	4.0	4.6	5.3	6.0	6.6	7.3	8.0	8.6	9.3	9.9	13.2	16.6
19	135.0	0.7	1.5	2.2	3.0	3.7	4.4	5.2	5.9	6.7	7.4	8.2	8.9	9.6	10.4	11.1	14.8	18.5
20	121.0	0.8	1.7	2.5	3.3	4.1	5.0	5.8	6.6	7.4	8.3	9.1	9.9	10.7	11.6	12.4	16.5	20.7
21	109.0	0.9	1.8	2.8	3.7	4.6	5.5	6.4	7.3	8.3	9.2	10.1	11.0	11.9	12.8	13.8	18.3	22.9
22	98.0	1.0	2.0	3.1	4.1	5.1	6.1	7.1	8.2	9.2	10.2	11.2	12.2	13.3	14.3	15.3	20.4	25.5
23	88.5	1.1	2.3	3.4	4.5	5.7	6.8	7.9	9.0	10.2	11.3	12.4	13.6	14.7	15.8	17.0	22.6	28.2
24	80.5	1.2	2.5	3.7	5.0	6.2	7.5	8.7	9.9	11.2	12.4	13.7	14.9	16.2	17.4	18.6	24.8	31.1
25	73.5	1.4	2.7	4.1	5.4	6.8	8.2	9.5	10.9	12.2	13.6	15.0	16.3	17.7	19.1	20.4	27.2	34.0
26	68.0	1.5	2.9	4.4	5.9	7.4	8.8	10.3	11.8	13.2	14.7	16.2	17.7	19.1	20.6	22.1	29.4	36.8
27	62.5	1.6	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	32.0	40.0
28	57.0	1.8	3.5	5.3	7.0	8.8	10.5	12.3	14.0	15.8	17.5	19.3	21.1	22.8	24.6	26.3	35.1	43.9
29	52.0	1.9	3.9	5.8	7.7	9.6	11.5	13.5	15.4	17.3	19.2	21.2	23.1	25.0	26.9	28.9	38.5	48.1
30	48.0	2.1	4.2	6.3	8.3	10.4	12.5	14.6	16.7	18.8	20.8	22.9	25.0	27.1	29.2	31.3	41.7	52.1
31.	44.5	2.3	4.5	6.7	9.0	11.2	13.5	15.7	18.0	20.2	22.5	24.7	27.0	29.2	31.5	33.7	44.9	56.2
32	42.0	2.4	4.8	7.1	9.5	11.9	14.3	16.7	19.1	21.4	23.8	26.2	28.6	31.0	33.3	35.7	47.6	59.5
33	40.0	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	50.0	62.5
34	38.0	2.6	5.3	7.9	10.5	13.2	15.8	18.4	21.1	23.7	26.3	29.0	31.6	34.2	36.8	39.5	52.6	65.8
35	36.0	2.8	5.6	8.3	11.1	13.9	16.7	19.4	22.2	25.0	27.8	30.6	33.3	36.1	38.9	41.7	55.6	69.4
36	34.0	2.9	5.9	8.8	11.8	14.7	17.7	20.6	23.5	26.5	29.4	32.4	35.3	38.2	41.2	44.1	58.8	73.5
37	32.0	3.1	6.3	9.4	12.5	15.6	18.8	21.9	25.0	28.1	31.3	34.4	37.5	40.6	43.8	46.9	62.5	78.1
38	30.0	3.3	6.7	10.0	13.3	16.7	20.0	23.3	26.7	30.0	33.3	36.7	40.0	43.3	46.7	50.0	66.7	83.3
39	28.0	3.6	7.1	10.7	14.3	17.9	21.4	25.0	28.6	32.1	35.7	39.3	42.9	46.4	50.0	53.6	71.4	89.3
40	26.0	3.9	7.7	11.5	15.4	19.2	23.1	26.9	30.8	34.6	38.5	42.3	46.2	50.0	53.9	57.7	76.9	96.2

The relation between the percentages arrived at by the proposed method of expressing medullation and those by the calculated method is shown by a correlation coefficient of 0.99, which indicates the consistency of agreement. The above tests show that the percentage of medullation may be determined by the proposed method with accuracy adequate for the application of this method to sheep breeding programs.

It has been found that around 60 samples of wool can be cross-sectioned and appraised for fineness, variability, and percentage medullation by one operator in a 7-hour day when this method is used in conjunction with the rapid comparator method, whereas only 40 samples can be analyzed in a day if the count method is used.

Summary

1. A rapid method has been described for expressing medullation in wool samples in percentage.

2. This method is easily used with the rapid comparator method, which makes it possible to determine fineness, variability, and medullation at the same operation.

3. This method has been shown to be adequately accurate for application to problems involving the study of medullation in fleeces on a comparative basis.

Literature Cited

(1) Hardy, J. I., 1935. Determination of fiber fineness and cross-sectional variability. Textile Res. 5: 184-190, illus.

(2) Hardy, J. I., and Wolf, H. W., 1939. Two rapid methods for estimating fineness and cross-sectional variability of wool. U. S. Dept. Agr. Cir. 543, 16 pp., illus.

(3) Pohle, E. M., 1940. The application of a rapid comparator method for determining fineness and variability in wool. Proceedings of the American Society of Animal Production, pp. 161-168, illus.

(4) Wilson, J. F., 1929. The medullated wool fiber. Hilgardia, Vol. 4, No. 5, pp. 135-152, illus.

Reports of Sales for Fiscal Year 1941

Date	S. S. Nos.	Description	Amount
7- 3-40	2244A	Sale surplus sheep pelts	$ 201.11
9-11-40	2245A	Sale 267 hd. wether lambs	1,553.37
9-23-40	2246A	Sale 481 hd. wethers, ram & ewe lambs, & rams	2,512.18
9-25-40	2247A	Sale 206 hd. wether, ewe and ram lambs	1,106.92
10- 5-40	2248A	Sale surplus wool (payment on account)	10,000.00
10-14-40	2951A-2982A & 2250A	Sale 314 hd. rams, ewes, & ram & ewe lambs	6,676.12
10-16-40	2983A	Sale 169 hd. ewes	899.65
10-18-40	2984A-2985A	Sale ram and ram lamb	53.00
10-22-40	2986A	Sale surplus wool (final payment)	659.11
11- 5-40	2987A	Sale ram	50.00
1-16-41	2988A	Grazing fee (leased lands)	80.27
1-30-41	2989A	Sale wether and 4 ewes for slaughter	21.47
2-24-41	2990A-2991A	Sale 2 ewes & 2 wether lambs for slaughter, & 14 ewes & 6 ewe lambs	418.74
3-26-41	2992A-2993A	Sale 2 wether lambs for slaughter, & surplus pelts	123.83
5- 7-41	2994A	Sale surplus scoured wool	227.03
5- 9-41	2995A-3000A, 3401A-3408A	Sale 99 orphan lambs	24.60
6-19-41	3409A-3413A	Sale 22 orphan lambs	5.39
		Total cash receipts for fiscal year	$ 24,612.79

Summary:

1123 head of rams, ewes, wethers, and wether, ewe and ram lambs sent to market	$ 6,072.12
314 head of rams, ewes, and ewe & ram lambs sold at annual sale	6,676.12
23 head of rams, ewes, and ewe & ram lambs sold for use as breeding stock	503.00
11 head of wethers, ewes and wether lambs sold for slaughter	52.81
121 orphan lambs sold	29.99
Total receipts from sales of sheep	$ 13,334.04
" " " " " wool in grease	10,659.11
" " " " " scoured wool	227.03
" " " " " pelts	312.34
" " " leading of land	80.27
	$ 24,612.79

Add:

Wool from yearling Rambouillet ewes shipped to Miles City 3668 lbs. @ 31½¢	1,155.42
Wool transferred to Agricultural Marketing Service 3150 lbs. @ 31½¢	992.25
	$ 26,760.46

Weather:

The 1940 precipitation totaled 15.77 inches as compared with the 15 year average of 9.85 inches. This was the heaviest annual precipitation since 1924 when precipitation totaled 16.53 inches. Heavier than normal precipitation during the first four months accompanied by higher than average mean temperatures started the spring growth of grasses and weeds earlier than normal so that it was possible to put ewes with lambs out to graze April 20th which is about 5 days earlier than usual. Range feed was abundant and quite choice during the first part of May but due to very limited precipitation in May began to get too tough for lambs to do well by the latter part of May.

Normal precipitation in June softened the feed enough so that the lambs did fairly well until feed on the high summer range was ready. The abundance of cured feed on the ground increased the hazard of range fires during August when precipitation was below normal. While an abundance of rain in September caused a reduction in the nutritive value of the cured grasses it also was responsible for considerable new growth so that the sheep did exceptionally well on fall range until hard frosts about the first part of December.

Mean temperatures for 1940 were higher for each month excepting November than for the 15 year average.

The following is a tabulation of precipitation and mean temperature for the year 1940:

Month	Precipitation		Mean temperature	
	1940	15 year average	1940	15 year average
January	0.99	0.73	20.30	17.81
February	1.47	0.65	24.80	23.06
March	1.33	0.57	33.00	30.46
April	1.46	0.77	43.20	42.43
May	0.30	1.00	55.56	53.39
June	1.21	1.14	64.40	60.77
July	1.01	0.76	70.20	69.45
August	0.77	0.91	70.40	66.82
September	3.91	0.81	57.27	54.85
October	1.31	1.05	47.55	45.23
November	0.91	0.63	27.23	30.90
December	1.10	0.83	25.19	21.46
Total	15.77	9.85	Average 44.93	43.10

Sheep Inventory, June 5, 1941

Breed	Mature ewes	Yearling ewes	Total	Mature rams	Yearling rams	Total	Wethers
Columbias & potential Columbias	485	159	644	23	44	67	
Corriedales	175	78	253	15	14	29	
Targhees	182	86	268	15	30	45	
Rambouillets:							
R series	154		154	30		30	
RW "	99	72	171	34	37	71	
W "	383	176	559	96	63	159	
Ramb "	76		76				
RS "	445		445				
S "	489	8	497	5		5	
Purchased				15		15	
B Corriedales	26		26				
U. S.	23	9	32				
Wethers							10
Shipped to Miles City March 12:							
Rambouillets:							
W series		58	58				
RW "		5	5				
S "		286	286				
Total	2537	937	3474	233	188	423	10

Total ewes on hand one year or over	3474
" rams " " " " " "	423
" wethers " " " " " "	10
" lambs " " (1941 lamb crop)	2358
Grand total -	6265

Fleece Weights 1941

Breed	Mature	Yearling
Ewes:		
Corriedale	10.77	10.73
Columbia	11.70	12.03
Targhee	10.66	10.84
Rambouillet	10.60	10.76
Rams:		
Corriedale	16.05	14.38
Columbia	17.89	15.89
Targhee	16.38	13.97
Rambouillet	15.48	14.78

General average:	1940	1941
Mature ewes	10.82	10.90
Yearling ewes	11.16	11.05
Mature rams	16.78	16.08
Yearling rams	13.17	14.88

The fleeces in 1941 appeared in general cleaner than in 1940 which may be due to the heavier precipitation and consequently less dust in 1941 than in 1940.

Body Weights of Ewes 1939-1940

	Mature ewes		Yearling ewes	
Breed	After shearing	At culling	After shearing	At culling
Columbia	135	145	106	121
Corriedale	114	126	83	100
Targhee	118	128	95	110
Rambouillet:				
Series "R"	121	131		
" "RW"	103	116	81	95
" "W"	107	120	84	100
" "Ramb"	127	134		
" "RS"	124	128		

Ewe Losses by Periods (Dead and Missing)

	Percent Mature Ewes
Breeding to lambing	0.7
Lambing to shearing	3.2
Shearing to breeding	2.8
Total	6.7

Publications

1. The following papers have been published since the beginning of the Western Sheep Breeding Laboratory:

"Measurement of reproductive capacity as an aid in selection of rams of high fertility (A preliminary report)" by C. E. Terrill, Proceedings of the American Society of Animal Production, 1937.

"Another experiment on long range paternity in sheep" by C. E. Terrill and E. M. Gildow, Journal of Heredity, Vol. XXIX, No. 2, Feb. 1938.

"Reproductive capacity of Rambouillet ram lambs as indicated by semen tests", by C. E. Terrill, Proceedings of the American Society of Animal Production, 1938.

"Selection of range Rambouillet ewes", by C. E. Terrill, Proceedings of the American Society of Animal Production, 1939.

"Reproduction in range sheep", by C. E. Terrill and John A. Stoehr, Proceedings of the American Society of Animal Production, 1939.

"Genetics and range sheep improvement", by Julius E. Nordby, Scientific Monthly, October, 1940, Vol LI, pages 310-320.

"The application of a rapid comparator method for determining fineness and variability in wool", by Elroy M. Pohle, Proceedings of the American Society of Animal Production, 1940.

"Comparison of ram semen collection obtained by three different methods for artificial insemination", by Clair E. Terrill, Proceedings of the American Society of Animal Production, 1940.

"Sheep improvement for range production", by Julius E. Nordby, Idaho Forester, Vol. XXIII, 1941.

2. The following papers have been multigraphed since the beginning of the Western Sheep Breeding Laboratory:

"The Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station", by Julius E. Nordby, published in Extension Animal Husbandman, September, 1940.

"A rapid method for expressing medullation in wool", by Elroy M. Pohle, Animal Husbandry Division No. 41, May 1941.

"The Targhee breed of sheep and its place in range sheep production", by Julius E. Nordby, Animal Husbandry Division (in process of multigraphing).

"The Columbia breed of sheep and its place in range sheep production", by Julius E. Nordby, Animal Husbandry Division (in process of multigraphing).

3. The following papers to which contributions were made from this Laboratory have been published since the beginning of the Western Sheep Breeding Laboratory:

"Growth in Corriedale and Rambouillet sheep under range conditions", by Ralph W. Phillips, John A. Stoehr, and G. W. Brier, Proceedings of the American Society of Animal Production, 1940.

"Artificial insemination of ewes with transported semen", by E. M. Gildow, and C. E. Terrill, Journal of American Veterinary Medical Association, Volume XCIII, N. S. 46, No. 3, September 1938, pp.157-159.

"A summary of three years' work in the transportation of ram semen for artificial insemination", by Ralph W. Phillips, R. G. Schott, E. M. Gildow and C. E. Terrill, to be published in the Proceedings of the Second National Meeting of Veterinary Surgeons of Italy, 1940.

"Artificial insemination of ewes", by C. E. Terrill and E. M. Gildow, National Wool Grower, Volume 27, No. 2, December, 1937.

4. The following papers have been published from data or by use of materials collected at the Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station:

"Some factors affecting the progeny testing of rams", by Ralph W. Phillips, R. G. Schott, W. V. Lambert and G. W. Brier, U. S. D. A. Circular No. 580, October, 1940.

"A preliminary study of the relation between the fleece characteristics of weanling and yearling range sheep", by W. V. Lambert, J. I. Hardy and R. G. Schott, Proceedings of the American Society of Animal Production, 1938.

"Comparison of the accuracy of two methods of estimating fineness of wool fibers, by Ralph W. Phillips, R. G. Schott, J. I. Hardy and H. W. Wolf, Journal of Agricultural Research, Vol. 60, No. 5, March 1, 1940, pages 343-350.

From Lava Rock to a Garden in Three Years

Meetings Attended from July 1, 1940 to June 30, 1941 by Members of the Staff

Thirty-third annual meeting of the American Society of Animal Production, November 29 to December 1, 1940, Chicago, Illinois and International Livestock Exposition were attended by:

Julius E. Nordby
Clair E. Terrill, who delivered a paper entitled "Comparison of ram semen collection obtained by three different methods for artificial insemination".
Elroy M. Pohle reported on "The application of a rapid comparator method for determining fineness and variability in wool".

Western sectional meeting of the American Society of Animal Production, June 14-15, 1941, Logan, Utah:

Clair E. Terrill reported on "Face covering in range sheep" which paper is in process of multigraphing.
Elroy M. Pohle presented a paper on "A rapid method of expressing percentage of medullation in wool". This paper is now multigraphed as A.H.D. No. 41, May 1941.

The National Ram Sale, Salt Lake City, Utah, was attended by Mr. Nordby.

Travel and Visits to Agricultural Experiment Stations, Woolen Mills and Wool Scouring Plants

Elroy M. Pohle visited the following: Federal Prison Industries wool scouring and manufacturing plant at El Reno, Oklahoma, where cooperative manufacturing tests on Dubois wools are being conducted. Texas A. and M. College including their new wool scouring plant and wool laboratory at College Station, Sonora Range Experiment Station at Sonora and various wool warehouses enroute. The Southwestern Sheep Breeding Laboratory, Fort Wingate, New Mexico; the Wyoming Experiment Station wool laboratory and experiment station, and newly constructed wool laboratory at Logan, Utah.

In December he visited the Bureau of Animal Industry wool scouring and animal fiber technology laboratories, Beltsville, Md.; the Agricul-

tural Marketing Service wool scouring laboratories, Washington, D. C., in the interest of cooperative wool scouring with wools from this Station; laboratories of the cotton section of the U. S. Department of Agriculture relative to grades and new length testing apparatus, and testing laboratories of the Bureau of Home Economics, Washington, D. C. The Forstmann Woolen Co., Passaic, N. J., for consultation on problems with Dr. Werner von Bergen, Director, Research and control laboratories, and the Botany Worsted Mill Laboratories, Passaic, N. J., were also visited.

Clair E. Terrill visited the H. C. Gardiner Montana sheep ranch at Anaconda, in the interest of a cooperative breeding undertaking and also the Ernest White Columbia sheep were inspected by him at Kalispell, Montana.

He visited research workers and laboratories at the following experiment stations on his summer vacation: Minnesota, Wisconsin, New York, Beltsville, Md., and Ames, Iowa.

Mr. Nordby gave talks at the annual meeting of the Idaho Wool Growers, Pocatello, Idaho and the Western Montana Wool Growers, Poulson, Montana, and was in attendance at the National Wool Growers Annual Meeting held at Spokane, Washington.

Agricultural experiment stations visited during the fiscal year ending June 30, 1941, were Oregon, Washington, Idaho, Utah, Montana, Illinois and Iowa. The experiment stations of Arizona, New Mexico, Colorado and Wyoming were visited early in the calendar year 1940. Visits have also been made to numerous flocks and to woolen mills during the year.